THE HIGH SPEED ELECTRONICS GROUP

Microwaves & RF

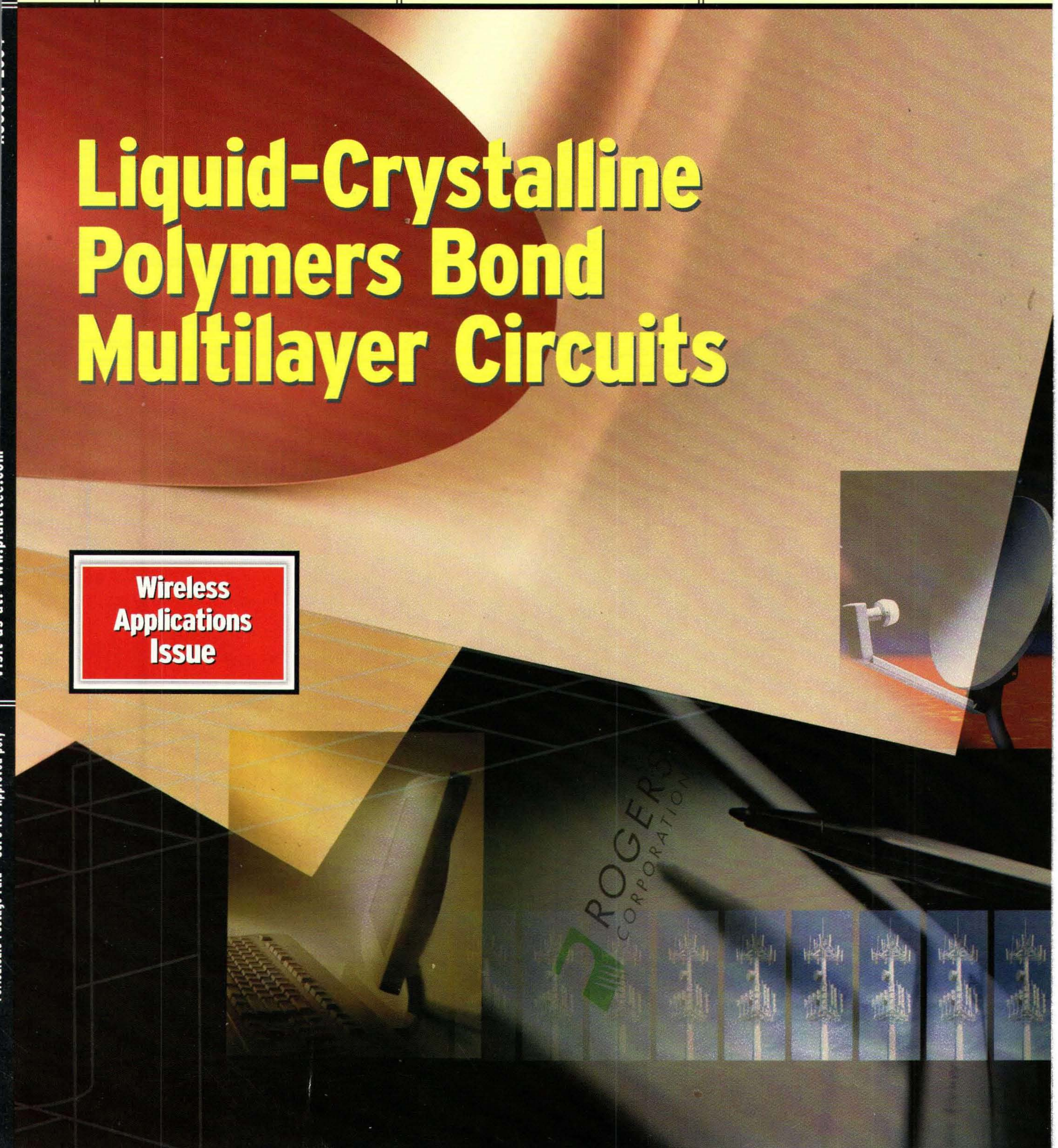
News
Technologies combine for broadband solutions

Design Feature
Optically sculpt UWB waveforms

Product Technology
Field-strength analyzer scans 100 kHz to 2.9 GHz

Liquid-Crystalline Polymers Bond Multilayer Circuits

Wireless Applications Issue



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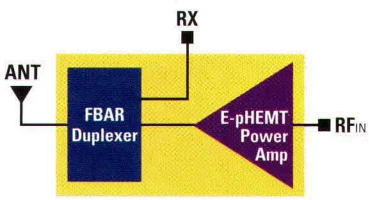


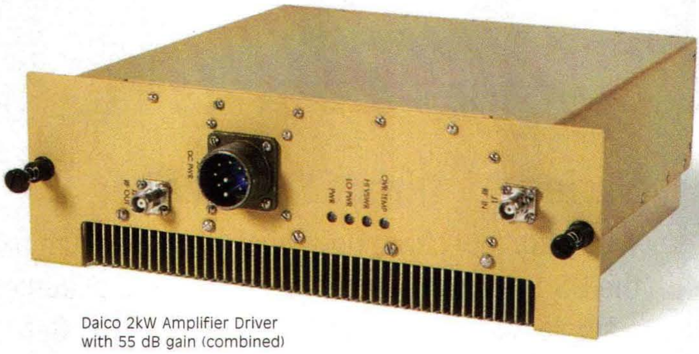
CDMA 1900 FEM Example Block Diagram

www.agilent.com/view/performance

Agilent Technologies

dreams made real

OK, WE ADMIT IT... WE'RE INTO MUSCLE AMPLIFIERS



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ELECTRICAL SPECIFICATIONS

Parameter	Min	Typ	Max	Unit	Notes
Frequency	1.2		1.4	GHz	
Small Signal Gain	53	55	58	dB	
VSWR In/Out			1:2/1		In 50 ohm
RF Out, P1DB Comp.		+63	63.3	dBm	
Harmonics Out II, III	50	55		dBc	
Gain Tracking	-0.3	0.2	+0.3	dB	Unit-to-unit
Phase Tracking between amplifiers	-1.0	±-0.5	+1.0	degree	Unit-to-unit
VSWR Withstand Under Full Power			∞:1		All phases
Efficiency		30			
Duty			10	%	
Pulse Width	0.001		1.0	Msec	
Pulse Droop	0.0	0.02	0.1	db	

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AUGUST 2004 • VOL. 43 • NO. 8

Microwaves & RF

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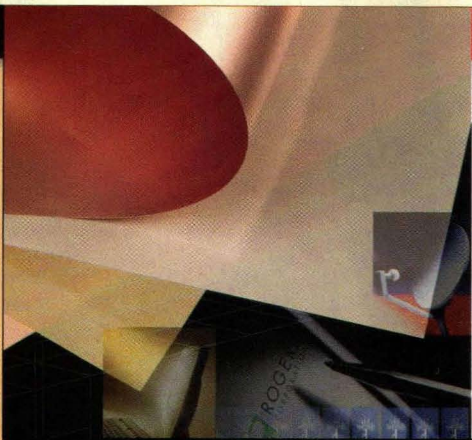
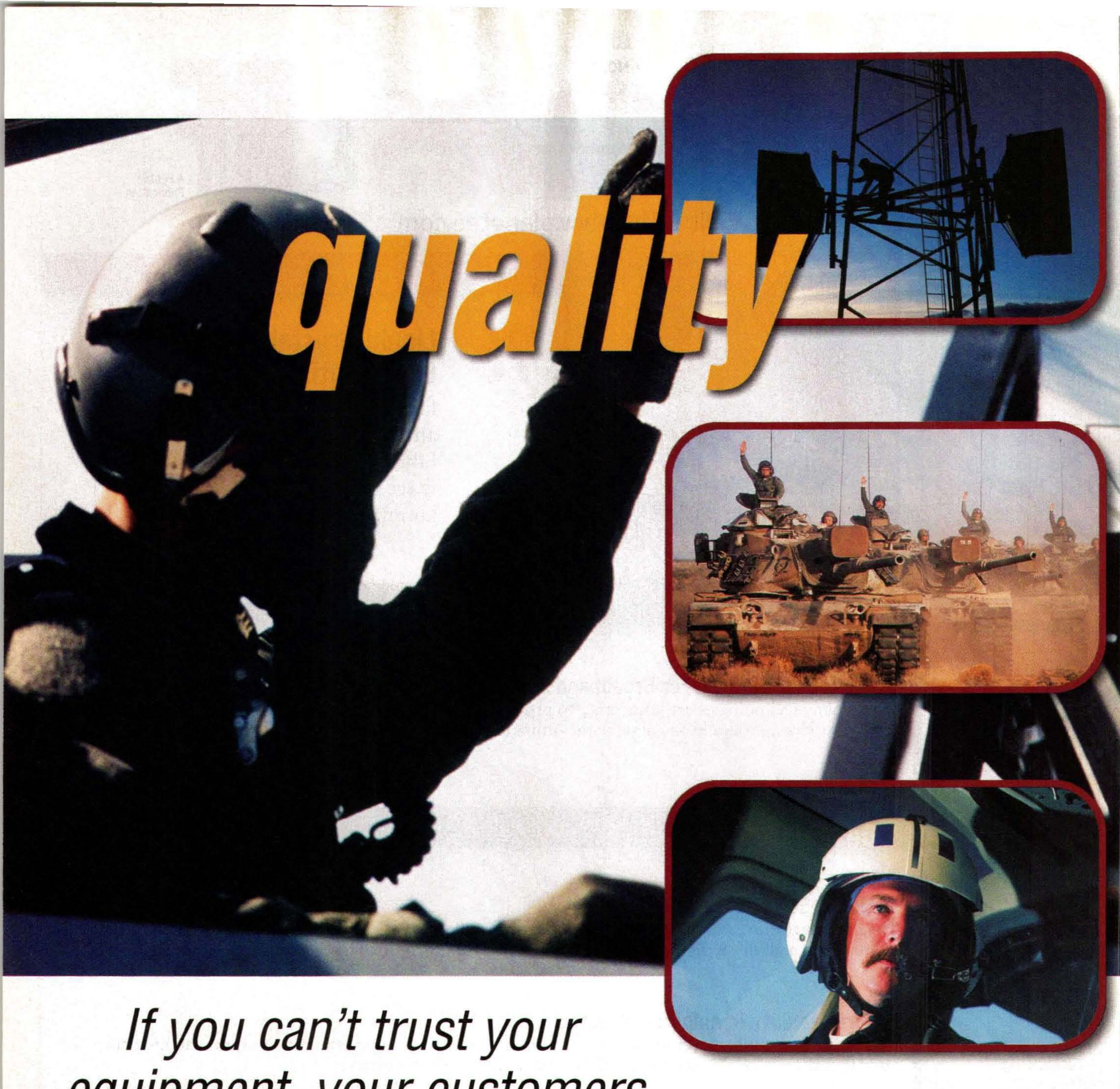


COVER STORY

News

Design

Product Technology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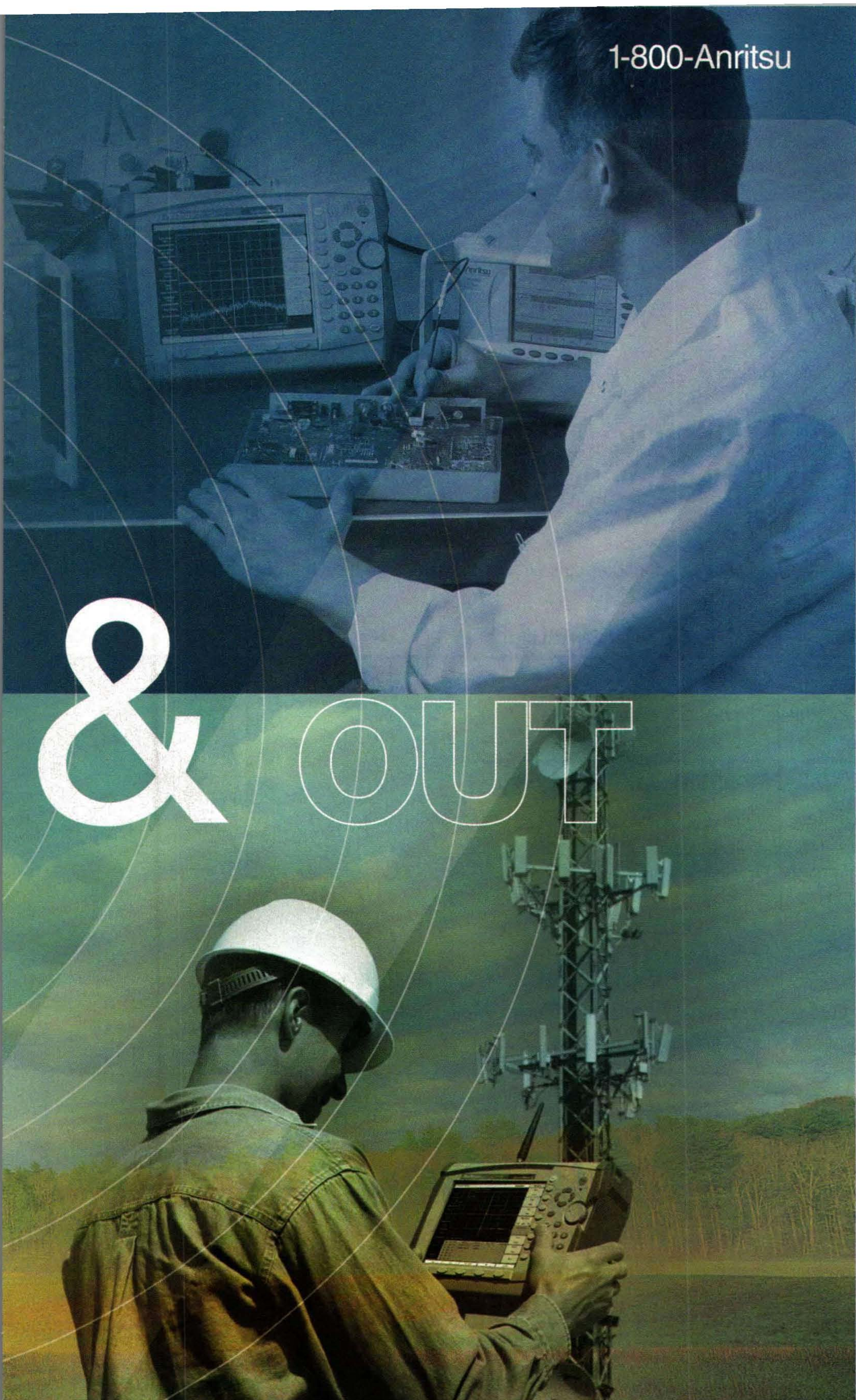

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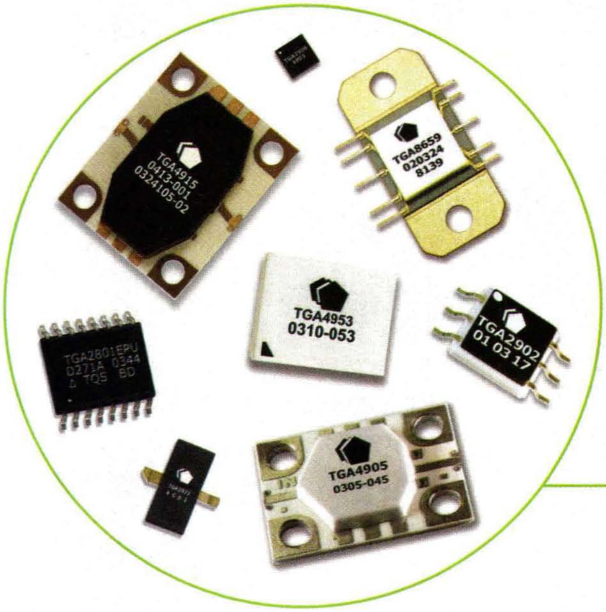
Great Things Come In Small Packages

Making a good product better is sometimes just as obvious as putting it in the right package. TriQuint Semiconductor has done just that with many of our DC to 80 GHz products.

What's behind these new packages? Innovative ideas that match our high performance devices to application-specific packaging. We're maximizing performance and minimizing price with new packaging. Offering more than just convenience, these new products deliver performance and cost advantages that have people talking.

Consider the new TGA4915-CP high-power Ka Band VSAT and radio transmit amplifier. It enables subsystem designers to replace expensive multi-chip modules to reduce complexity and cost. Another new packaged part is the TGA4953-SL 10Gb/s optical modulator driver, which provides superior eye quality and low power dissipation in an easy-to-use surface mount package. What's inside TriQuint's new packages? Performance. Reliability. Lower system cost.



Description	Part Number	Package Style
CATV HPA	TGA2801D	-SG
CATV TIA / LNA / Gain Block	TGA2803	-SM
2.6GHz 10W HPA	TGA2924	-SD
3.5GHz 5.6W HPA	TGA2925	-SD
802.11a 5.8GHz 4W HPA	TGA2921	-SG
802.11a 5.8GHz 2W HPA	TGA2922	-SG
5-15GHz LNA / Driver w/AGC	TGA2512	-SM
2-20GHz LNA / Driver w/AGC	TGA2513	-SM
10Gb/s High Gain MZ Driver	TGA4953	-SL
10Gb/s MZ Driver	TGA8652	-SL
Ku Band VSAT Driver	TGA2507	-SM
Ku Band HPA	TGA2508	-SM
Ku Band 1W HPA	TGA2903	-SG
Ku Band 2W HPA	TGA2902	-SG
Ku Band 4W HPA	TGA8659	-FL
Ku Band 6.5W HPA	TGA2514	-FL
Ku Band 2W High Gain HPA	TGA2904	-FL
Ka Band 2W HPA	TGA4513	-CP
Ka Band 4W HPA	TGA4905	-CP
Ka Band 7W HPA	TGA4915	-CP

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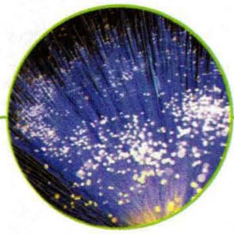

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Design Feature Correction

▶▶DUE TO AN EDITORIAL oversight, corrections that were supposed to be inserted into the Design Feature "ESD-Hardened Device Fuels UHF Amplifiers" (July 2004, p. 57) did not appear. We apologize to the article's authors, Jakob Huber and Gerard Wevers, and our readers for the oversight. The intended corrections were inserted to the version of the article that appears on our website. The corrected article can be found on the Web at www.mwrf.com/Articles/ArticleID/8501/8501.html.

The Editors of Microwaves & RF

Pardon My French Redux

▶▶RE THE LETTER "Pardon My French, But . . ." (Feedback, June 2004, p. 13): It is certainly true that US export licensing is causing us (the United Kingdom) to avoid using US parts that are subject to these restrictions for certain types of work. For us, this is mainly MMICs and RF devices. Often, the end items are for export as well as UK Ministry of Defense (MoD) use, so ultimate users are not known at the development stages of a program. We cannot guess who the US are going to ban as an end user, so we avoid the situation by not using US parts.

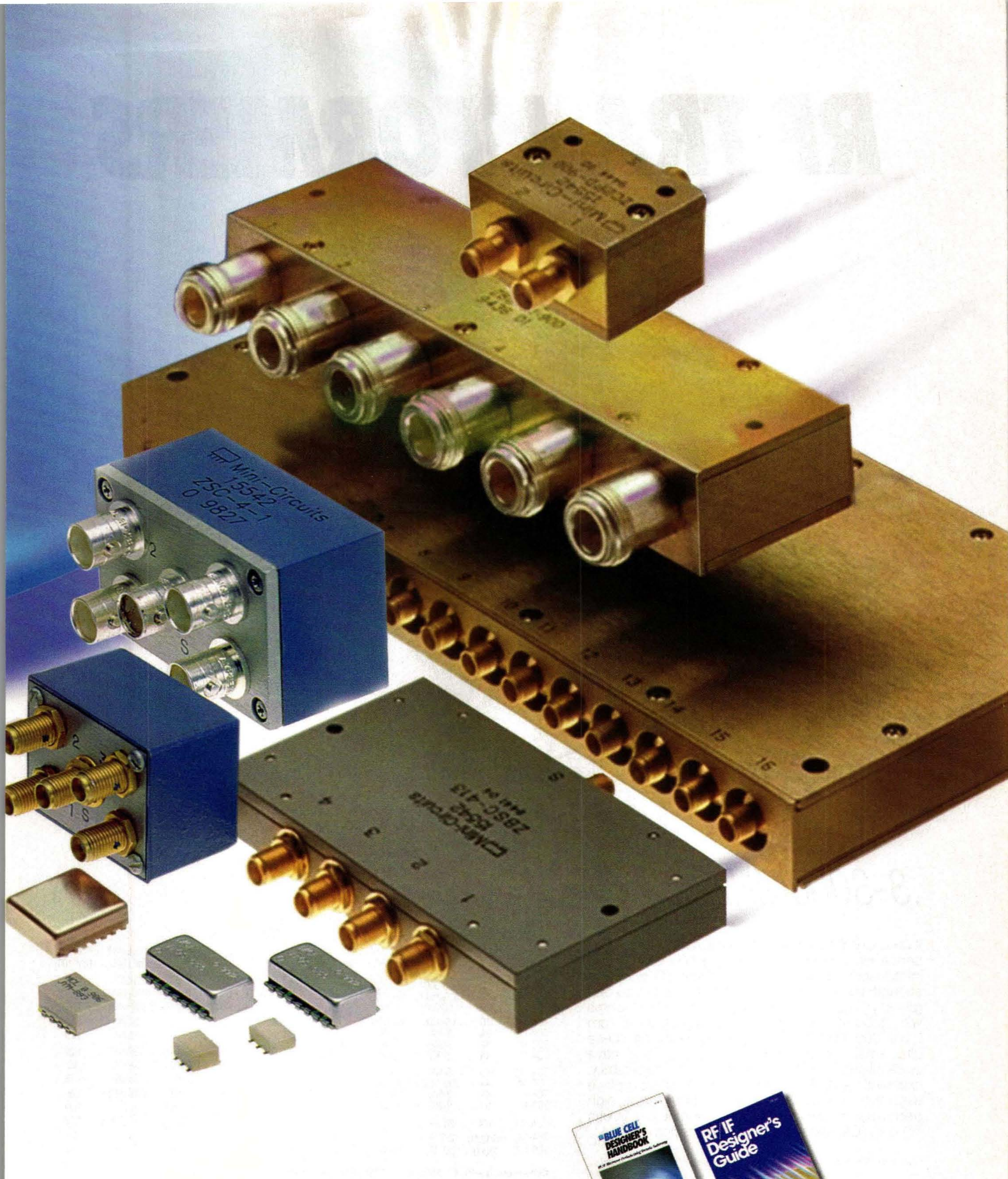
Name Withheld By Request

Reader Questions Article

▶▶IN THE ARTICLE "Antenna Snares GPS/WLAN Signals" (written by Dr. Jamal S. Izadian, June 2004, p. 58), I would take issue with the argument concerning the gain of a microstrip patch antenna. The author refers to the two-slot model of a patch antenna, writing that the gain of a single slot is 2.1 dBi, and, therefore, the gain of two slots would be 5.1 dBi. The problem is that 2.1 dBi is the gain of a slot that radiates on both sides of an infinite ground plane. When the slot is forced to radiate on only one side of the ground plane, as the model assumes, the gain of the single slot becomes 5.1 dBi, and the gain of two slots becomes 8.1 dBi.

This, of course, is a rather simple model, but, in fact, gains of 9 dBi are commonly achieved with patch antennas when the dielectric material has properties close to those of air. This can be quickly shown on any EM simulation tool, or, with slightly more time, can be measured on a working model. Patch antennas with lower gain levels result from the choice of other dielectric models.

Gary Sanford
California Amplifier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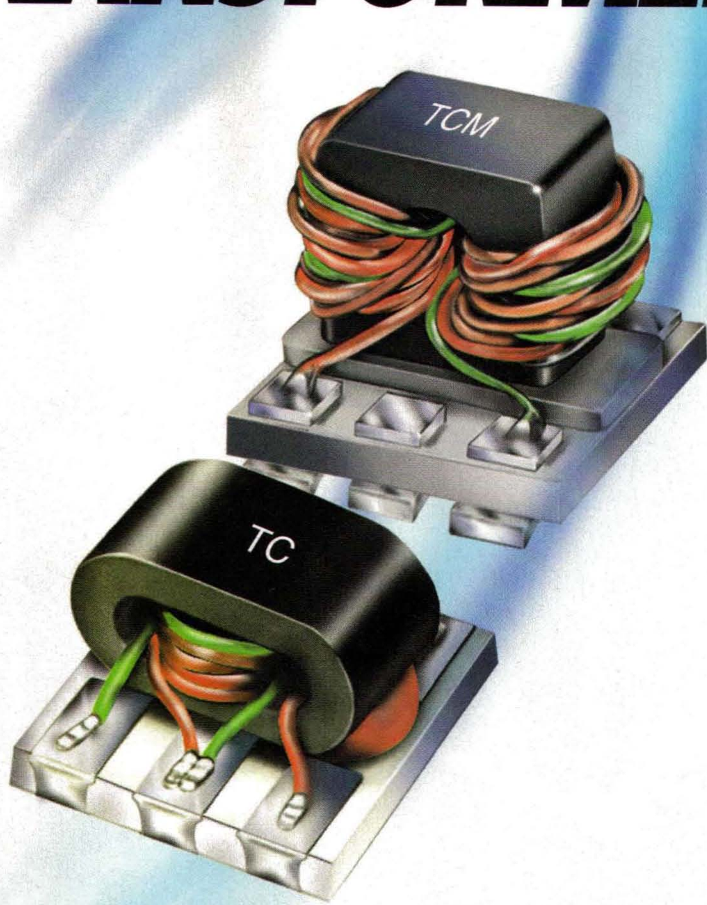
RF/IF Designer's Guide

RF TRANSFORMERS



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TC1-1	1C	1.5-500	5-350	1.19
TC1-15	1C	800-1500	800-1500	1.29
TC1.5-1	1.5D	.5-2200	2-1100	1.59
TC1-1-13M	1G	4.5-3000	4.5-1000	.99
TC2-1T	2A	3-300	3-300	1.29
TC3-1T	3A	5-300	5-300	1.29
TC4-1T	4A	.5-300	1.5-100	1.19
TC4-1W	4A	3-800	10-100	1.19
TC4-14	4A	200-1400	800-1100	1.29
TC8-1	8A	2-500	10-100	1.19
TC9-1	9A	2-200	5-40	1.29
TC16-1T	16A	20-300	50-150	1.59
TC4-11	50/12.5D	2-1100	5-700	1.59
TC9-1-75	75/8D	0.3-475	0.9-370	1.59

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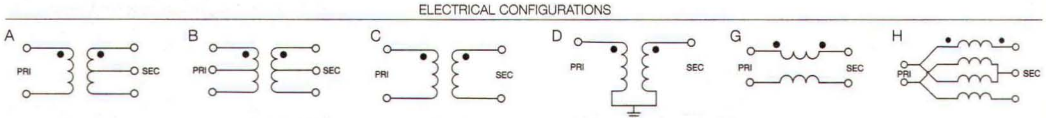
TCM1-1	1C	1.5-500	5-350	.99
TCML1-11	1G	600-1100	700-1000	1.09
TCML1-19	1G	800-1900	900-1400	1.09
TCM2-1T	2A	3-300	3-300	1.09
TCM3-1T	3A	2-500	5-300	1.09
TTCM4-4	4B	0.5-400	5-100	1.29
TCM4-1W	4A	3-800	10-100	.99
TCM4-6T	4A	1.5-600	3-350	1.19
TCM4-14	4A	200-1400	800-1000	1.09
TCM4-19	4H	10-1900	30-700	1.09
TCM4-25	4H	500-2500	750-1200	1.09
TCM8-1	8A	2-500	10-100	.99
TCM9-1	9A	2-280	5-100	1.19

Dimensions (LxW): TC .15" x .15"   TCM .15" x .16"   ❖Referenced to midband loss.

ELECTRICAL CONFIGURATIONS



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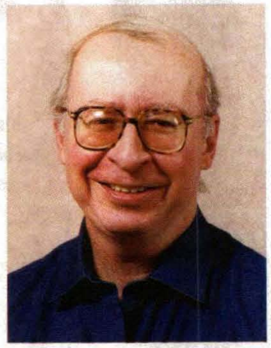
377 Rev. D

Trying To Define Broadband Systems



ASSEMBLING THE SPECIAL REPORT on "Broadband Technologies" beginning on p. 33 proved to be more than just the routine task of compiling data and making telephone calls. Occasionally, a term becomes so ubiquitous that its original meaning becomes distorted. Such has been the case with "wireless technology" (which most folks accept as synonymous with "cell phone") and appears to be the case with "broadband technology."

Attaching meaning to any term related to technology is an evolving process almost by definition. In the wireless case, for example, at one time the cellular telephone was a fairly representative product of the technology. Today, however, wireless has come to mean much more, in terms of short-range technologies such as Bluetooth and ultrawideband (UWB) approaches, network technologies such as IEEE 802.11a/b/g/n wireless local-area networks (WLANs), and microwave/millimeter-wave radio point-to-point technologies.

In trying to define broadband technologies, the critical information for most systems is data and video.

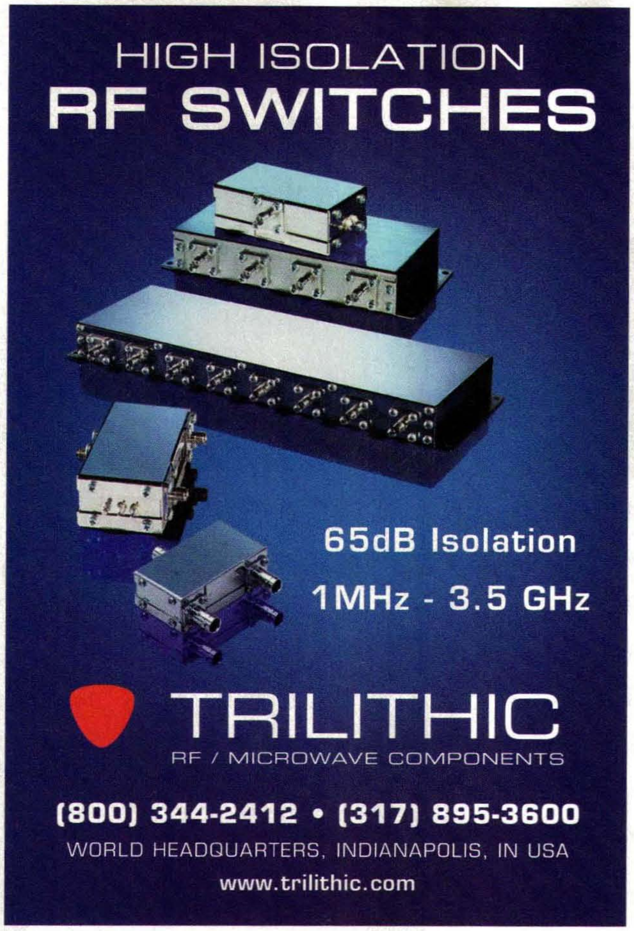
In trying to define broadband technologies (ignoring for the moment the implications of military systems), the critical information for most systems is data and video. Because of the near-term importance of high-speed Internet access, current suppliers of broadband hardware promote their Internet Protocol (IP) capabilities and maximum data rates. Data rates, of course, vary greatly from system to system and what was considered broadband a decade ago might is nearly obsolete now (remember the 56-kb/s modem?). By the same token, today's high-speed technology may be inadequate for a customer's needs a few years' hence.

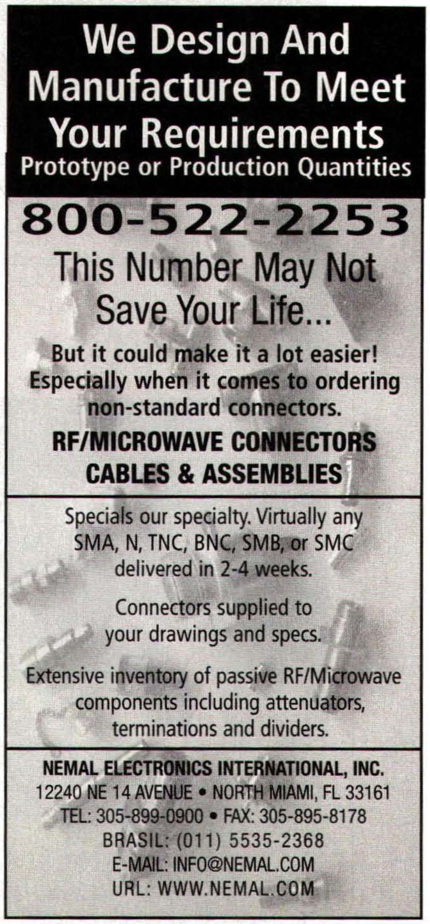
It is not surprising to find companies associated with computers and the Internet, such as Cisco Systems, Intel, and Microsoft, to be at the forefront of efforts to define broadband technology. All three have made technical presentations at past Wireless Systems Design Conference & Expo (formerly the Wireless Symposium & Exhibition) promoting their roles in wireless solutions. All three would just as quickly admit that a true broadband solution could just as easily include optical fibers as wireless transceivers.

A true long-term broadband technology solution is one that will offer high-speed data and video beyond today's definition of high speed or broadband. It may consist of a hybrid mix of such technologies as UWB, optical, and millimeter-wave technologies that do not have the inherent bandwidth limitations of their lower-frequency counterparts, such as cellular and WLAN technologies, especially for that cost-sensitive "last mile" connection to a subscriber's home. In any case, broadband applications will not be served by any one technology, but represent opportunities for many.

Jack Browne

Publisher/Editor





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HIGH-SPEED ELECTRONICS GROUP

Group Publisher Craig Roth, (201) 845-2448 • croth@penton.com

Publisher/Editor Jack Browne, (201) 845-2405 • jbrowne@penton.com

Technology Editor Nancy K. Friedrich, (201) 845-2428 • nfriedrich@penton.com

Managing Editor John Curley, (201) 845-2415 • jcurley@penton.com

Special Projects Editor Alan ("Pete") Conrad

Editorial Assistant Dawn Prior • dprior@penton.com

Contributing Editors Andrew Laundrie, Allen Podell

MANUFACTURING GROUP

Group Production Director Mike McCabe

Customer Service Representative

Dorothy Sowa, (201) 845-2453, fax: (201) 845-2494

Production Coordinator Judy Osborn, (201) 845-2445

Digital Production Staff Louis Vacca, Pat Boselli

ART DEPARTMENT

Art Director Patrick Prince • pprince@penton.com

Group Design Manager Anthony Vitolo • tvitolo@penton.com

Senior Artist James M. Miller

Staff Artists Linda Gravell, Michael Descul

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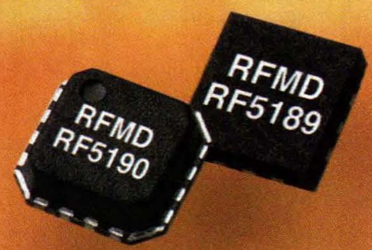

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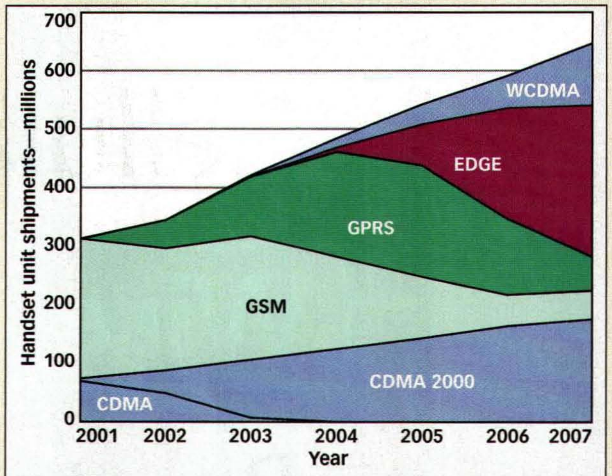
EDGE Will Displace GSM And GPRS Over The Next Two Years

AUSTIN, TX—According to information from Silicon Laboratories, Inc., many industry researchers believe that EDGE (Enhanced Data Rates for GSM Evolution) will begin to rapidly displace GSM and GPRS over the next two years **(see figure)**, while WCDMA grows steadily but experiences less significant market penetration. In North America, GSM operators are implementing EDGE as a cost-effective means of providing high-speed data comparable to competing CDMA2000 services. In Europe and Asia, some operators have already paid large spectrum license fees for WCDMA, and are under active contracts with the governments to roll out WCDMA services. These operators may implement EDGE as a complementary service to WCDMA, allowing data services outside the pockets of WCDMA coverage. Other operators who avoided the WCDMA licensing fees may look to EDGE as a cost-effective service to provide high-speed data in existing GSM spectrum. Either way, EDGE is expected to be deployed in the majority of handsets with a steep production ramp starting in 2005.



Source: Deutsche Bank, Jan. 2004

Silicon Laboratories has announced the Aero™ EDGE Radio for GSM/GPRS/EDGE cellular handsets. Based on Silicon Laboratories' Aero transceiver technology, a GSM/GPRS/EDGE radio can be implemented with 50 percent less board space and 60 percent fewer components compared to competing solutions. The Aero EDGE Radio is qualified for components sourced from multiple vendors.

Zarlink's Technology Is Selected For Swallowable Camera Pill

OTTAWA, ONTARIO, CANADA—Zarlink Semiconductor announced that Given Imaging Ltd., maker of the world's only swallowable camera capsule for diagnosis of disease of the gastrointestinal tract, is now using an ultra low-power transmitter chip from Zarlink in its M2A capsule endoscope.

The defining characteristic of Zarlink's custom RF transmitter—its miniscule power consumption—assures the operating life and image capabilities of the camera capsule as it passes through a patient's esophagus, stomach, and small intestine.

The M2A capsule—consisting of a microchip camera, light-emitting diodes that act as a flash, Zarlink's RF transmitter chip, antenna, and two silver-oxide batteries—is swallowed by the patient and then passes naturally through the digestive tract. The cameras images are relayed by the RF transmitter to a data recorder in a belt worn by the patient, who is free to continue with normal daily activities throughout the exam.

Data is then downloaded to a workstation equipped with proprietary image-processing software, and a video of the gastrointestinal tract is produced revealing pathologies and diseases of the small intestine that were previously undetected by traditional diagnostic tools.

Kevin Rubey, COO of Given Imaging, says, "We believe that Zarlink's ultra low-power RF transmitter can lead to improved future performances of the Given® Diagnostic System M2A Capsule, as capsule endoscopy becomes a more common examination procedure."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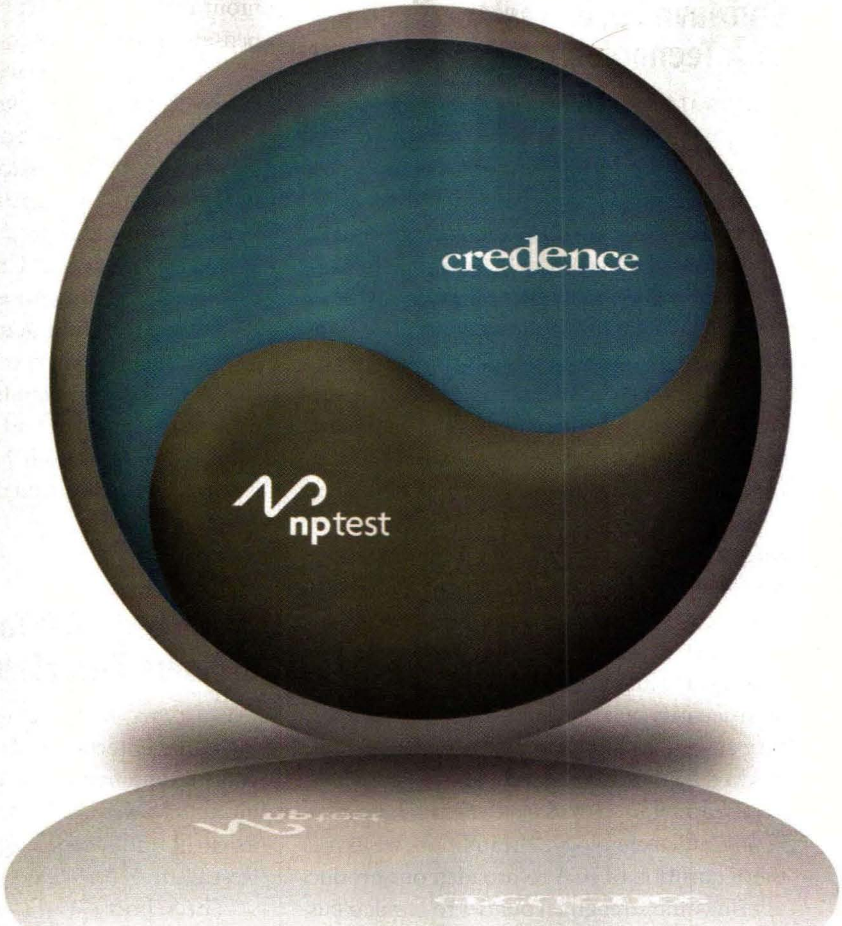
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Endwave Corp. Has Acquired JCA Technology, Inc.

SUNNYVALE, CA—Endwave Corp., a provider of RF subsystems for aero-defense, security, and commercial wireless applications, has announced the acquisition of all of the outstanding shares of capital stock of JCA Technology, Inc., a wholly owned subsidiary of Bookham Technology plc for approximately $6 million in cash.

JCA has a 20-year history in providing state-of-the-art RF amplifiers and modules to the defense, commercial-radar, and homeland-security markets. These products are broadly used in applications such as electronic warfare, radar, and secure communications. JCA's customer base is spread across multiple defense contractors and subcontractors, with no customer representing greater than approximately 15 percent of revenues in recent quarters.

"This acquisition is strategically important to Endwave in building our defense and homeland-security business base, and is complementary to our existing portfolio of RF module products for these markets," comments John Mikulsky, Endwave's senior vice president of sales, marketing, and technology. "In addition, we expect the acquisition of JCA to broaden our product offerings and strengthen our ties to familiar customers such as Raytheon, Northrop Grumman, Lockheed, L3, and Boeing."

"Wi-Fi will continue to work its way into home-entertainment networking, and will become entrenched."

WJ Communications To Acquire Some Assets From EiC Corp.

SAN JOSE, CA—WJ Communications, Inc., a designer and supplier of RF semiconductors and multi-chip modules, has announced a definitive agreement to acquire the wireless-infrastructure business and associate assets of privately held EiC Corp. of Fremont, CA. EiC designs, develops, manufactures, and sells proprietary RF integrated circuits (RF ICs) primarily for wireless-communications products.

EiC presently markets and sells a broad portfolio of power-amplifier (PA) products for wireless infrastructure such as cellular, PHS and PAS base stations, repeaters, wireless LANs, cable television, and optical networks.

Under terms of the agreement, WJ Communications will pay approximately $12.5 million in cash and stock for the assets being acquired from EiC. Additionally, if the EiC operations achieve certain revenue and margin targets over a 24-month period, EiC will receive further compensation of up to $14 million in a combination of stock and cash. The acquisition of EiC is subject to customary closing conditions.

"This acquisition further enhances WJ's strategy of offering customers what we believe is the leading infrastructure RF IC product portfolio in the industry," states Michael Farese, Ph.D., president and CEO of WJ Communications. "Including the effects of synergy revenues, we expect the acquisition to contribute $8 to $10 million in revenues over the next 12 months, while also significantly expanding our addressable market and accelerating the continuing roll out of our high-power amplifiers through the acquisition of significant IP and in process R&D."

Wi-Fi And UWB To Play Leapfrog In Home Entertainment

OYSTER BAY, NY—Technologies for networking home-entertainment equipment will compete for dominance over the next five years, but ultimately Wi-Fi will use 802.11n to continue its early lead, according to a study from ABI Research.

The report, *Wi-Fi Home Entertainment Networks*, identifies three candidates for wireless home-entertainment networking: powerline networking, Wi-Fi (802.11x), and Ultra Wide Band (UWB). ABI Research believes that the real contest will be between Wi-Fi and UWB.

Phil Solis, ABI Research senior analyst, points out that although the official data-transmission rate of the 802.11a and 802.11g protocols is 54 Mb/s, the actual throughput is only about half that, due to the communications overhead required.

The UWB standard will offer theoretical speeds up to 480 Mb/s, says Solis. However, the first generation of UWB chip sets coming off the assembly lines in 2005 and into actual equipment in 2006-07, will only offer 100 to 200 Mb/s, and that doesn't take the required overhead into account.

Meanwhile, the standard for the next member of the 802.11 family—802.11n—will have been ratified. The result? "Wi-Fi will continue to work its way into home-entertainment networking, and will become entrenched," comments Solis. "By the time UVB comes out—or just a little later—802.11n solutions will start to appear."

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S12W2	S12W5	N12W5	12	±0.60
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Network Helps Police Upgrade Their Communications Systems

MARCO ISLAND, FL—Nova Engineering, Inc., developer of the world's first commercial mobile ad hoc networking (MANET) device, has announced the successful implementation of a wireless mesh network deploying NovaRoam® Mobile Router units for the Marco Island, FL police department. Compatible with existing IP-based infrastructure applications, including CAD and records-management software as well as state and federal databases, the system transports mission-critical data to wireless laptops in police cruisers.

The power of the NovaRoam system is its ability to maintain robust communication links in dynamically changing wireless mesh networks using state-of-the-art MANET technology. Designed for demanding military applications, the NovaRoam products offer the type of secure, reliable communications required by today's public-safety organizations.

"NovaRoam was the ideal solution because of its extensive data throughput, coverage area, robust security measures, and mobile ad hoc networking technology," comments Officer Paul Keys, network administrator for the Marco Island Police Dept. (MIPD). "Additionally, the product fully met our budgetary constraints, which is always a consideration, particularly in public-safety environments."

"The product fully met our budgetary constraints, which is always a consideration, particularly in public-safety environments."

Unlike other commercially available wireless data products, NovaRoam offers broad-spectrum, high-speed (up to 1 Mb/s burst) communication coverage that spans miles, not just meters. The result is a highly adaptive and far-reaching network solution that allows mobile units fast, secure access to vital data to ensure public and officer safety.

In addition to having better-informed officers in the field, the NovaRoam system improves productivity. The MIPD estimates that the technology has saved an amount of time equivalent to eight full-time officers.

Eagleware And Sonnet Have Announced A Partnership

NORCROSS, GA AND SYRACUSE, NY—Eagleware Corp., a provider of high-frequency design software for RF and microwave design engineers, and Sonnet® Software, Inc., a provider of high-frequency planar electromagnetic (EM) analysis software, have announced a partnership to develop, market, and service the integration of Sonnet's EM simulation products into the popular GENESYS design environment. Included in the partnership are provisions to share licenses and to train their respective teams to support their common customer base.

"Interoperability with third-party tools, especially EM simulation tools, is absolutely critical for high-frequency EDA framework success in today's market," says James Rautio, president of Sonnet Software. "I am very impressed at how quickly and capably Eagleware engineers have developed what is clearly among the top EM-framework interfaces available today. We are very happy to see Eagleware take an active and aggressive position in third-party friendly EDA frameworks."

"We are delighted that Eagleware can now offer integrated access to customers who prefer to use the Sonnet EM family of simulators," states Todd Cutler, Eagleware's president. "We are particularly pleased to extend the reach of GENESYS' powerful circuit-EM co-simulation to a leading-edge EM simulator such as Sonnet's. We look forward to working with Sonnet Software to help engineers design better products, faster."

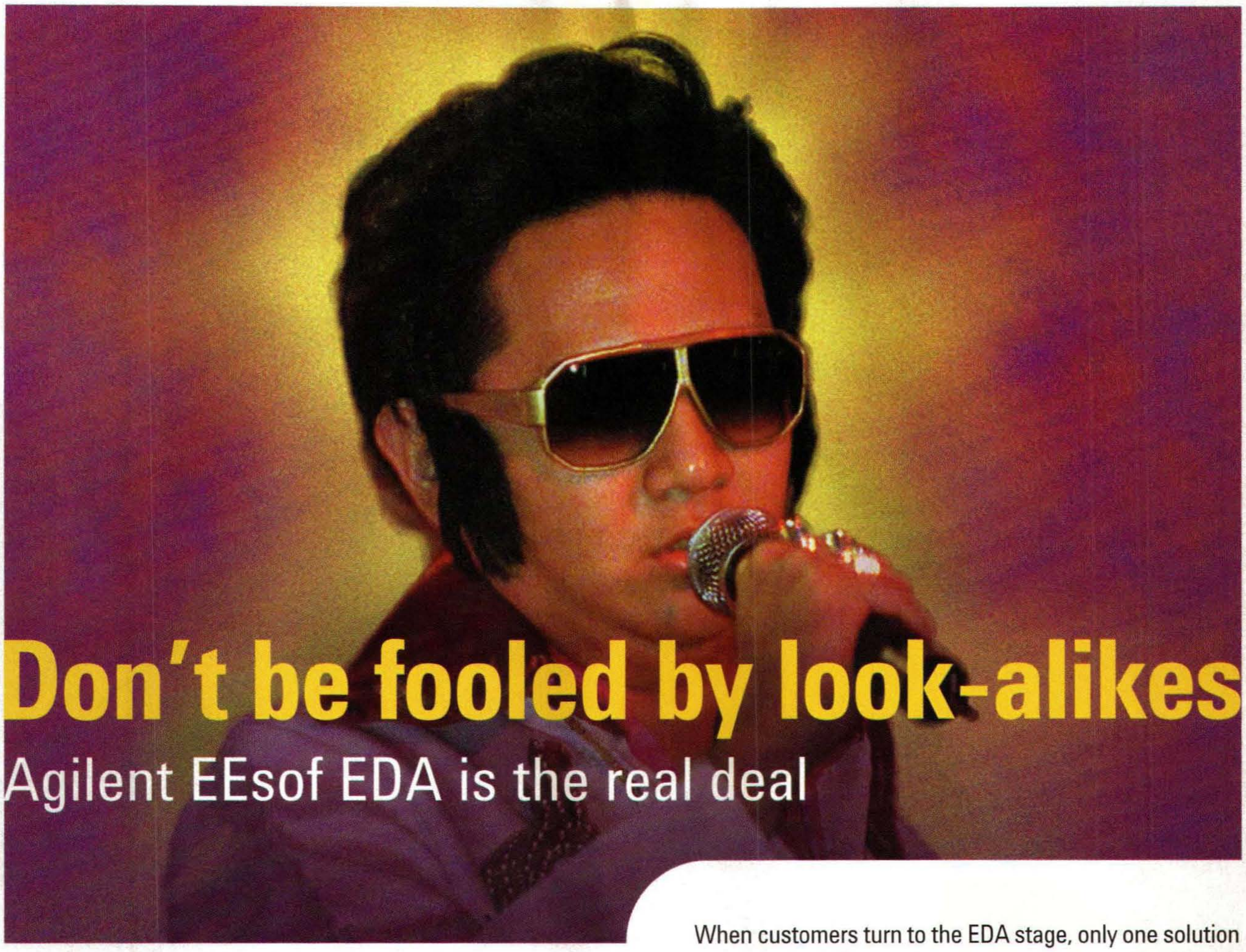
Sonnet integration is available with this summer's release of Eagleware's popular suite of design software for RF and microwave engineers, GENESYS 2004.

Kudos

MYRTLE BEACH, SC—AVX Corp., a supplier of electronic components, has received the *Corporate Environmental Achievement Award (CEAA)* from the American Ceramic Society, an organization dedicated to the advancement of ceramics. An awards banquet was held to formally recognize AVX during the Society's annual meeting in Indianapolis, IN.

BROOMFIELD, CO—Sirenza Microdevices, a designer and supplier of RF components for communications-equipment manufacturers, announced the award of US patent # 6,750,717 entitled "Peaking Control for Wideband Laser Driver Applications."

VISTA, CA—Palomar Technologies received the 2004 *Advanced Packaging Award* in the Specialized Advanced Packaging Equipment and Materials category at a ceremony held in July during SEMICON West in San Jose, CA. MRF



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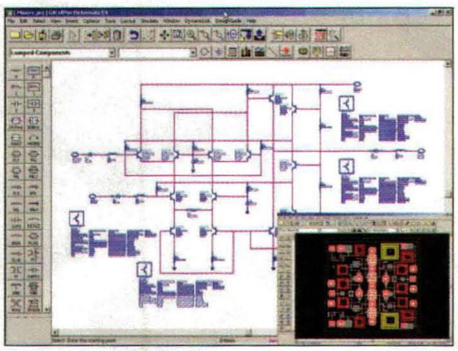

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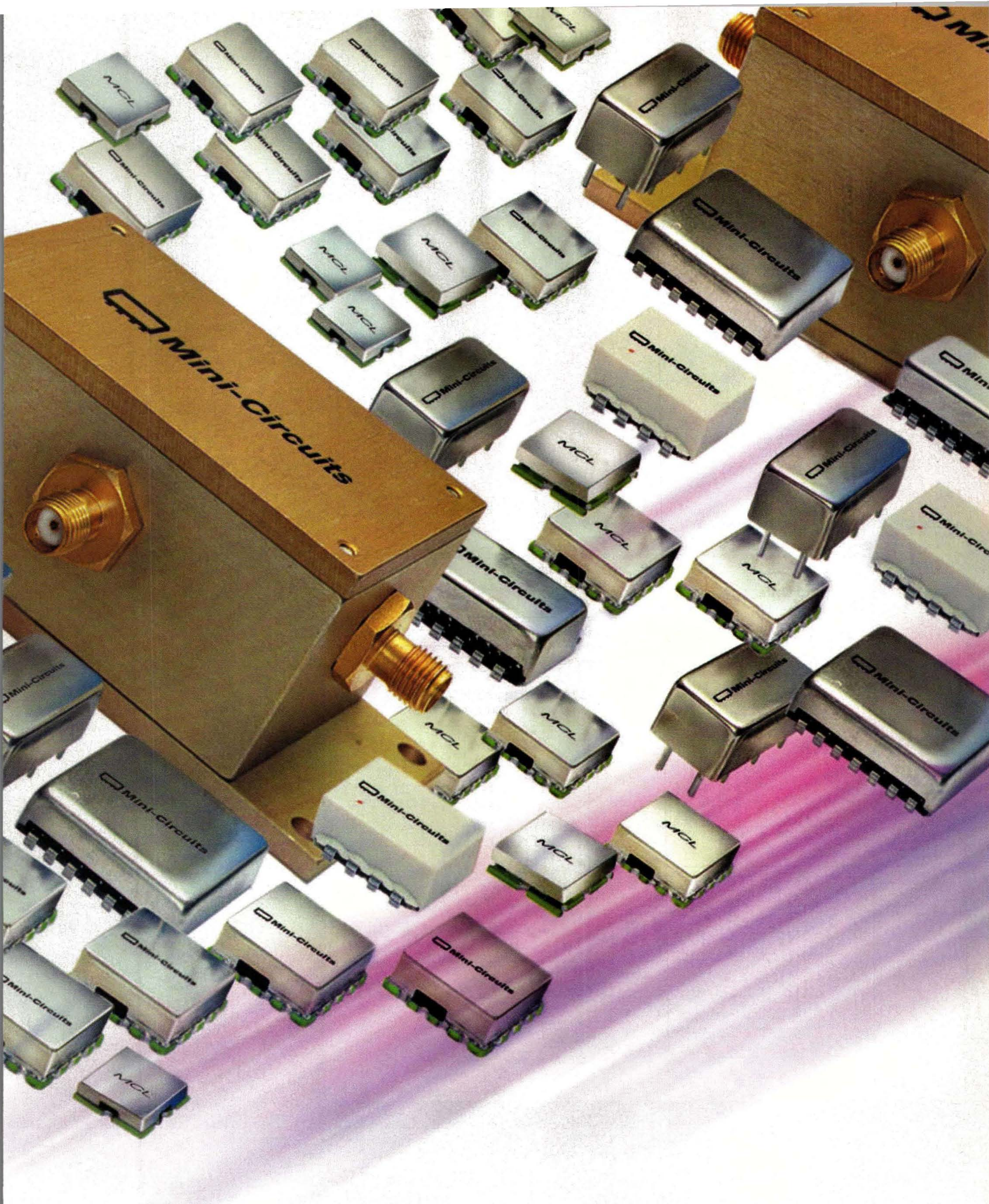
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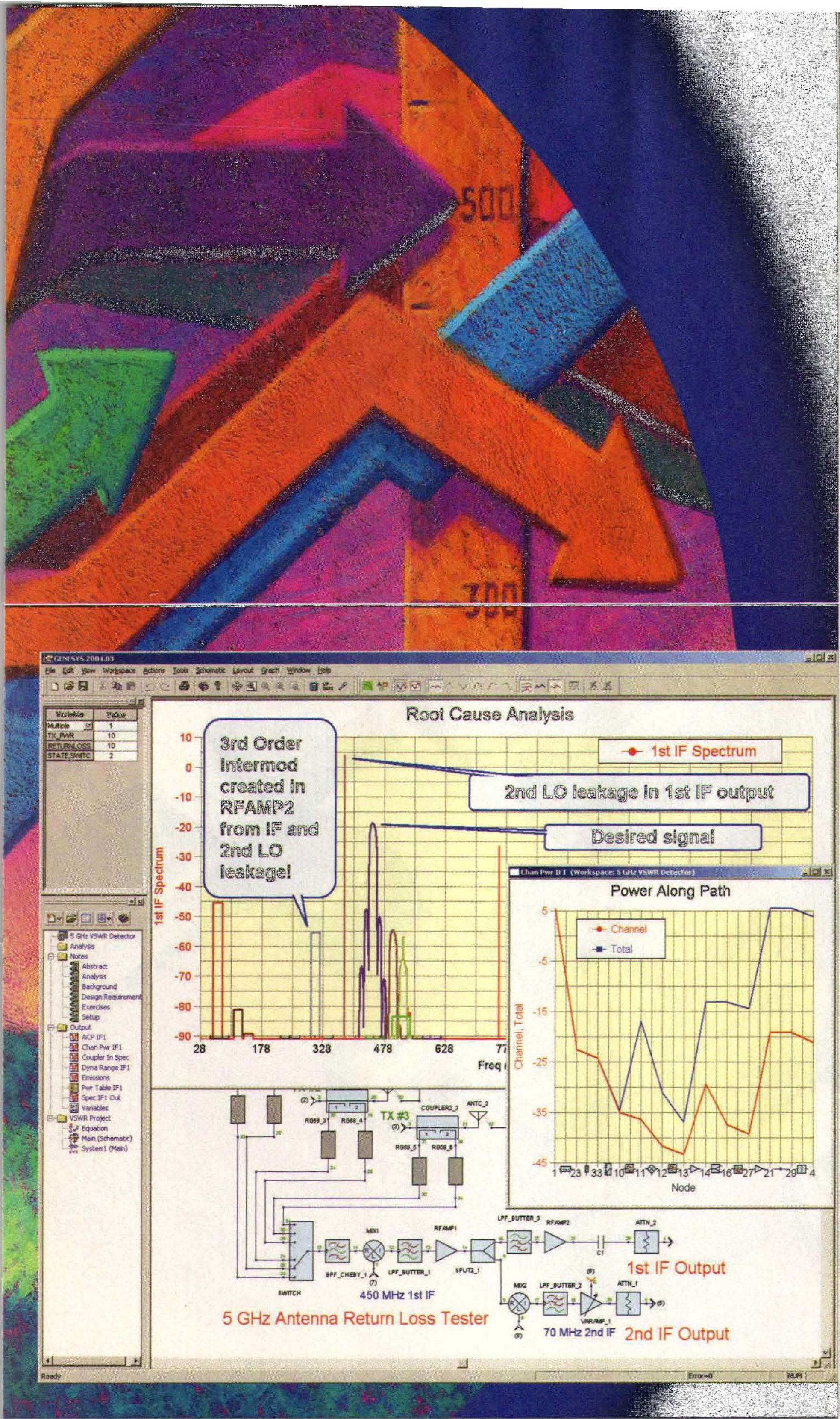
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NEWS

Technologies Combine For Broadband Solutions

JACK BROWNE
Publisher/Editor

While many technologies are competing to provide subscribers with affordable broadband communications services, no single one may be the ultimate solution.

Broadband is a word that once implied military radar systems operating from 2 to 18 GHz. The term has taken on different meaning in recent years, becoming almost synonymous with technologies that support commercial high-speed data communications. In fact, broadband technology is an umbrella term that now applies to a host of wired, wireless, and optical technologies for high-speed voice, data, and video communications.

What is driving an increased need for broadband communications? Factors include increased use of the Internet for sending large file attachments, the use of the Internet for multimedia content is growing, on-line gaming, growth of video conferencing or, in short, the growth of information in its various forms, including audio, voice, data, and video.

For example, the traditional model of video broadcasting has involved sending composite signals via RF channels to any number of customers in a reception area. With the inception of cable-television (CATV) services, the model included customers with access to a cable line. Newer models based on personalized broadcast services such as video on demand involve "broadcasting" programming to one customer at a time. The older models effectively used available bandwidth by allowing group access to common programming. With personalized broadcast services, the potential exists for any number of different program "packages," each with an allotment of bandwidth, whether access is wired, optical, or wireless.

It has become apparent that no single technology will serve the needs of global broadband access. In a white paper produced by Intel Corp., "Broadband Wireless: The New Era in Communications," Sean Maloney, executive vice president and general manager of Intel Communications Group notes that "it is not a case of one technology becoming universal, or one technology replacing another. The technologies will co-exist, creating more robust solutions that will enable a lot of new and exciting possibilities." The white paper, which is available for free download from the company's website (www.intel.com), includes third-generation (3G) cellular systems and wireless local-area networks (WLANs) at 2.4 and 5 GHz as part of the wireless portions of a global broadband network.

Software giant Microsoft (Redmond, WA, www.microsoft.com) has recognized the importance of broadband communications by forming the Windows Media Broadband Jumpstart initiative to work with partners and customers on jump-starting broadband business models. Before the broadband industry can take off, Microsoft feels that guiding principles for broadband access to be widely accepted include the following: the cost of broadband access needs to drop dramatically to be within the reach of most consumers; the quality of streamed video, which is limited by the architecture of the Internet, must be improved; compelling content needs to be developed so that consumers have a reason to invest in a broadband connection; and improved business models must be created to increase revenues and lower overall costs for the broadband industry.

The 3G cellular networks have been promoted as broadband networks capable of providing high-speed voice and data services, although these networks are still largely based on providing high-quality mobile voice services. Although these mobile-communications networks offer the promise of high-speed data access of typically 2 Mb/s, these data rates pale in comparison to broadband fiber-optic networks or even high-capacity WLANs. WLANs operate at several frequencies and data rates, such as the earliest IEEE 802.11b standard at 2.4 GHz and 11 Mb/s and the later IEEE 802.11a at 5 GHz and 54 Mb/s in the US.

Perhaps the greatest remaining hurdle to universal broadband communications access is what many have referred to as "the last mile" in the communications link. This last mile in a cable-television (CATV) network, for example, is the cable itself, since it is typically terminated in an access box or set-top receiver that is then connected to a customer's devices, such as a television set. A CATV infrastructure offers about 750 MHz of bandwidth (one 8-MHz analog video channel supports about 50 Mb/s data through a cable modem), but a single cable through a branch can only support a limit number of users, since each must occupy a separate portion of bandwidth.

The CATV infrastructure is presently used to provide broadband commu-

nications by means of cable modems. Although originally constructed with copper coaxial cables, most modern CATV systems are combinations of copper and fiber-optic cables known as hybrid fiber coax (HFC) systems. Fiber is typically used for long signal runs, with optical signals converted to electrical signals and carried along copper coaxial cables to subscribers.

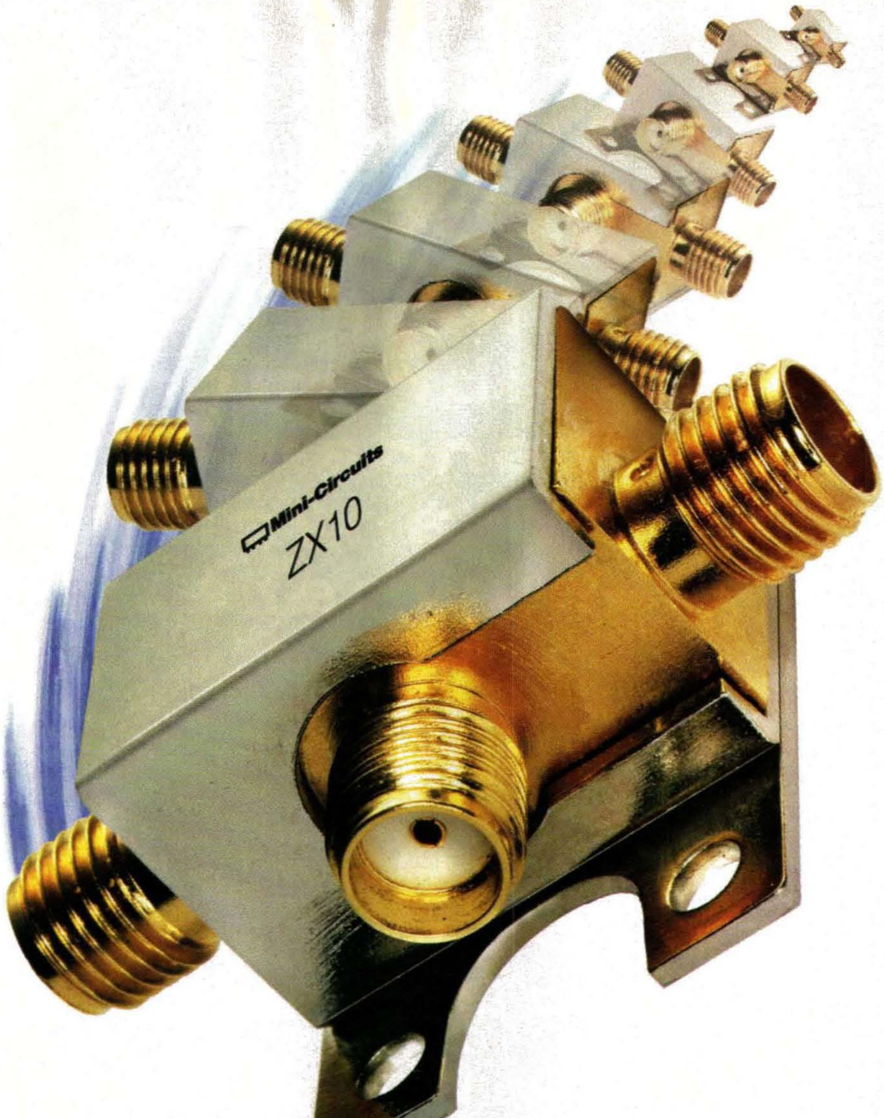
Signals in a broadband CATV network travel downstream (to the subscriber's cable modem) and upstream (from the subscriber's cable modem). Downstream signals in the US occupy 6-MHz channels (8 MHz in Europe) from 65 to 850 MHz while downstream signals are sent from 5 to 65 MHz in the US and 5 to 42 MHz in Europe, occupying typically 2-MHz-bandwidth channels. Downstream signals are modulated with 64-state or 256-state quadrature amplitude modulation (QAM) while upstream signals are modulated with 16QAM or quadrature-phase-shift-keying (QPSK) modulation.

Cable modems on a CATV network compete with integrated services digital network (ISDN) or digital subscriber line (DSL) technologies on twisted-pair copper cables as part of a wired broadband access solution, with rates ranging from about 128 kb/s for ISDN to a maximum of 50 Mb/s for DSL.

In 1998, the US Federal Communications Commission held the first of two auctions for 1.3-GHz of spectrum for local multipoint distribution service (LMDS) services from 28 to 31 GHz. The fixed broadband wireless service was expected to solve the "last-mile" access problem to homes and businesses. Ironically, the first FCC auction was not successful in selling the total of 986 licenses for 493 geographic basic trading areas (BTAs) in the US; a second auction was needed in 1999 to complete the sale of LMDS licenses.

Basically, an LMDS system consists of the network operations center (NOC), which houses the network management system, a fiber-based infrastructure to connect the separate NOCs, a base station which is usually mounted on a cellular communications tower (this is where the conversion from fiber to wireless takes place), and customer premises equipment (CPE) which is usually mounted on the outside of a customer's house and includes conversion and modulation/demodulation circuitry inside the house. The cellular-like LMDS technology relies on time-division-multiple-access (TDMA) and frequency-division-multiple-access (FDMA) technology to support multiple customers within a three-to-five-mile coverage radius with data rates from 64 kb/s to 155 Mb/s.

Unfortunately, because it operates at such high frequencies, LMDS has not



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ZX10-2-71	2.95-7.1	23	0.25	34.95
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ZX10-2-126	7.4-12.6	23	0.3	39.95
4WAY-0°			Above 6.0dB	
ZX10-4-11	.8-1.125	20	0.6	38.95
ZX10-4-14	1.1-1.45	20	0.8	38.95
ZX10-4-19	1.425-1.9	20	0.75	38.95
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enjoyed the rapid reductions in cost seen by chip sets and components at lower cellular frequencies. Since LMDS components approach millimeter-wave frequencies, they require much finer dimensions and manufacturing tolerances than their cellular/PCS counterparts, as well as more-expensive test equipment for testing. Although the LMDS infrastructure can be assembled with costs comparable to those of a cellular infrastructure, it is the high cost of the CPE gear that has proven to be a stumbling block for the widespread use of LMDS as a "last mile" solution.

Still, all the FCC licenses were sold, and a large number of telecommunications companies, including Cisco Systems, Motorola, and XO Communications, have invested in LMDS technology for their high-speed, high-bandwidth data links, with the hopes of ultimately expanding the infrastructure to the subscriber. Earlier this year, XO Communications announced successful trials of its LMDS-based broadband wireless access system in San Diego, CA and Irvine, CA. The company holds wireless licenses covering about 95 percent of the US population in the top 30 cities.

Amidst the long list of corporate LMDS license holders is Virginia Tech University (Blacksburg, VA, www.lmds.vt.edu/vtlmds.htm), the only university to hold LMDS licenses (four A-block LMDS licenses cover most of Southwest Virginia as well as parts of North Carolina and Tennessee). As part of the initial 1998 FCC auction, the Virginia Tech Foundation acquired these licenses via unopposed bidding. The licenses have a ten-year term with an opportunity for renewal provided that minimum infrastructure build-out requirements are met. (Each geographic area has two licenses, denoted A-block and B-block licenses, with some differences in spectrum.) The University's Center for Wireless Telecommunications (CWT), headed by Dr. Charles Bostian, has made use of the licenses to conduct research on the use of advanced wireless technology applied to rural mountainous areas. The licenses cover about 16,000 square miles and about 1.6 million homes. The universi-

ty will act not as a service provider but as a catalyst in the application of technology, working with service providers and equipment manufacturers to bring broadband services to the rugged area.

Some technologists are not daunted by the historically expensive costs of higher-frequency electronics as a solution for broadband communications. Doug Lockie, former Executive Vice-President of Endwave Corp. (Sunnyvale, CA) and author or co-author of nine patents in microwave and millimeter-wave components and subsystems, recently founded GigaBeam Corp. (Chantilly, VA) with Lou Slaughter, former CEO of Loea Communications Corp. Lockie serves as Chief Technology Officer (CTO) and Slaughter as Chief Executive Officer (CEO) for the new company. Motivated by the FCC's October 2003 ruling to authorize commercial licensing rules for millimeter-wave bands of 71 to 76 GHz, 81 to 86 GHz, and 92 to 95 GHz, Lockie, Slaughter, and company have developed point-to-point wireless systems based on millimeter-wave bands at 71 to 76 GHz and 81 to 86 GHz to transmit data at multigigabit-per-second rates. Although the high frequencies have traditionally represented high costs, the company points out the tremendous capacity represented by the spectrum, with 1 Gb/s being the equivalent of 1000 DSL lines or about 647 T1 lines.

Lockie's former company, Endwave Corp., features component- and system-level solutions at microwave and millimeter-wave frequencies, including transceivers from 11 to 95 GHz for data rates from 1.5 to 622 Mb/s. The firm's AllegrA lines of transceivers for PDH radios includes standard products at 18 through 38 GHz. Terabeam Corp. (www.terabeam.com) also offers point-to-point broadband systems such as its Gigalink product line at millimeter-wave frequencies, including a license-free 60-GHz system. Terabeam recently merged with YDI Wireless (Falls Church, VA, www.ydi.com) to become a wholly owned subsidiary of YDI.

The large potential market for last-mile broadband access has even spurred the development of some truly innovative ways to apply traditional technologies, such as free-space optics (FSO) in which line-of-sight lasers or light-emitting diodes (LEDs) are used to transmit voice, data, and video at bandwidths to 2.5 Gb/s over distances as great as 4 km. Developed over 30 years ago by the US military and NASA, the unlicensed broadband technology can support any communication protocol. Each FSO system consists of an optical transceiver with a laser transmitter and a receiver for full-duplex communications. Proponents of FSO technology such as LightPointe (San

Diego, CA, www.lightpointe.com) hope to increase bandwidth to 10 Gb/s in the near future through the use of wavelength-division-multiplexing (WDM) techniques. The company's FlightLite system, which is targeted at enterprise LANs, provides data rates to 1.25 Gb/s with a system package of less than 9 lbs.

Traditional fiber-optic systems should be part of the "mix" of technologies solving the "last mile" broadband access problem, with service providers such as Verizon Communications (www.verizon.com) recently revealing their intention to install optical last-mile connections to subscribers where feasible. Verizon announced last month that it would deploy the LambdaXtreme Transport system from Lucent Technologies (www.lucent.com) for its next-generation optical long-distance network. The DWDM-based system supports long-haul optical communications at 10 and 40 Gb/s, and carries as much as 2.56 Tb/s (64 channels at 40-Gb/s) channels for distances to 1000 km. Earlier in the year, Verizon completed deployment of a national broadband network of 9.7 million miles of fiber-optic cable as part of its Enterprise Advance growth initiative in support of broadband services.

Newer optical equipment providers such as Terrawave Communications (Hayward, CA, www.terawave.com) have built upon traditional fiber-optic technology through the use of a passive-optical-network (PON) approach. The company's technology exceeds the usual 20 km range of optical links though the use of low-loss optical splitters which allow branching the network into a large tree-like configuration covering an approximate 484 square-mile service area.

Additional "delivery" technologies for broadband services include satellite communications systems, such as the geostationary satellite networks managed by Intelsat providing broadcast, telephone, and Internet services, and the low-earth-orbit-satellite (LEOS) systems managed by Globalstar LLC (Milpitas, CA), as well as high-speed data access over power lines for data rates to 1 Gb/s.

All of these broadband system solutions pose challenges for component and device suppliers. For example, Dave Robertson, product line director, High-Speed Converters, at Analog Devices (Wilmington, MA) feels that broadband communications represents a "big crowd of opportunities with technologies at different levels of maturity." Given his company's wide array of device-oriented product lines, from data converters and logarithmic amplifiers to complete wireless chip sets, the firm would appear to be well poised to serve broadband communications no matter which system or systems ultimately handle the load. MRF

editor's choice

Surface-Mount Power Dividers Reach 2.4 GHz

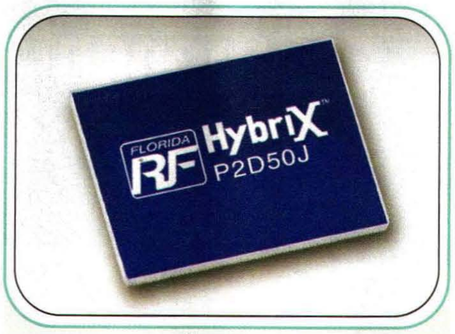
HYBRIX® SURFACE-MOUNT power dividers are Wilkinson-based components with high-power-handling capabilities in compact surface-mount packages. Initial product lines aim at cellular and wireless-local-area-network (WLAN) applications, such as the model HybriX P2S50D two-way divider which operates from 800 to 1000 MHz with 50-W power-handling capability and 16-dB isolation between ports. It measures a compact 16.51 × 12.19 mm. Model HybriX P2D50J is a surface-mount two-way power divider that handles 50 W power from 1700 to 2000 MHz while exhibiting at least 20 dB isolation. Model HybriX P3S35L is a three-way divider with 19 dB isolation and 35 W power-handling capability from 2 to 2.4 GHz, while model HybriX P4L50G is a four-way divider that handles 50 W input power from 1300 to 2000 MHz with at least 13 dB isolation between ports.

Florida RF Labs, 8851 SW Old Kansas Ave., Stuart, FL 34997; (772) 286-9300, FAX: (772) 283-5286, Internet: www.rflabs.com, www.smithsinterconnect.com.

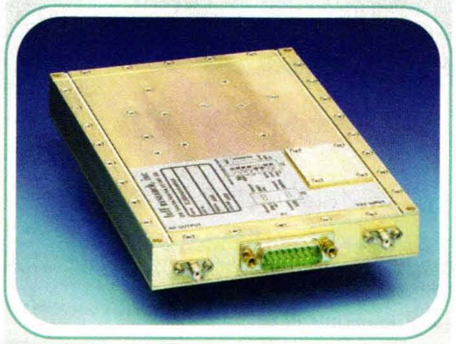
Frequency Synthesizers Tune From 4 To 10 GHz

FREQUENCY SYNTHESIZERS in the TLSD are capable of providing as much as 2-GHz bandwidth at frequencies from 4 to 10 GHz. Based on a proprietary voltage-controlled oscillator (VCO), these triple-loop designs tune typically in 100-kHz steps with +13-dBm output power across the tuning range. The phase noise is better than –90 dBc/Hz offset 10 kHz from an X-band carrier while spurious levels are –60 dBc. The synthesizers, which are housed in an EMI-shielded enclosure for ease of integration in system designs, can operate with an internal 10-MHz reference source (with ±1 PPM stability) or external reference sources running at 1, 5, 10, or 20 MHz.

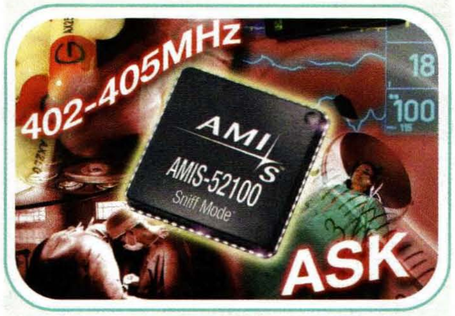
Luff Research, Inc., 20 North Tyson Ave., Floral Park, NY 11001-1514; (516) 358-2880, FAX: (516) 358-2757, e-mail: sales@luffresearch.com, Internet: www.luffresearch.com.



FLORIDA RF LABS' HYBRIX SURFACE-MOUNT POWER DIVIDERS



LUFF RESEARCH'S FREQUENCY SYNTHESIZERS



AMI SEMICONDUCTOR'S AMIS-52100 EVALUATION KIT

MECA ELECTRONICS' RF/MICROWAVE CIRCULATORS AND ISOLATORS

Kit Aids Designers Of Medical Implants

OPTIMIZED FOR EMERGING applications from 402 to 405 MHz per the medical implantable communications systems (MICS) standing, the AMIS-52100 evaluation kit allows designers to quickly test the AMIS-52100 low-power transceiver integrated circuit (IC) for its functionality in implantable medical devices and other applications below 500 MHz. The kit contains all the hardware, software, and documentation needed to evaluate the AMIS-52100 IC, which employs amplitude-shift-keying (ASK) modulation to provide data rates to 19.2 kb/s over a total range of 315 to 500 MHz. The kit includes a patent-pending Quick Start oscillator with fast 15-μs turn-on time that allows the transceiver to quickly power up in the presence of a signal when the IC is in its power-saving Sniff Mode™. P&A: $349.00; stock.

AMI Semiconductor, 2300 Buckskin Rd., Pocatello, ID 83201; (208) 233-4690, FAX: (208) 234-6795/6796, Internet: www.amis.com.

Circulators And Isolators Blanket 0.8 To 8.0 GHz

A LINE OF RF/MICROWAVE circulators and isolators is available for signal-control applications from 0.8 to 8.0 GHz. Circulator model CN-0.900, for example, operates from 800 to 1000 MHz with 0.4-dB maximum insertion loss and 20-dB minimum isolation. The rugged component has maximum VSWR of 1.25:1 and is rated for average power-handling capability of 250 W. It is supplied with Type N female connectors. The model CS-6.000 is an SMA circulator with maximum insertion loss of 0.5 dB from 4 to 8 GHz. The minimum isolation is 20 dB while the maximum VSWR is 1.35:1. The circulator is rated for 2 W average power over temperatures from –10 to +60°C. In the isolator line, model IS-1.950 is suitable for PCS applications from 1.7 to 2.2 GHz.

Meca Electronics, Inc., 459 East Main St., Denville, NJ 07834; (866) 444-6322, (973) 625-0661, FAX: (973) 625-1258, Internet: www.e-meca.com.

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French RFID Market Lags Behind UK

FOR MANY YEARS, the French have paid little attention to RFID technologies. But today, tags and readers—high-tech bar-code systems—appear to be following the same arduous way that the Internet took, struggling to find its first users despite being hailed as a revolution.

As far as RFID development is concerned, the French market lags behind its European neighbors, Germany and the UK. Although it is true that a number of companies have already sold RFID tags and readers for applications including transport or animal identification, only a handful of RFID suppliers have acquired customers for the new generation of RFID tags, encompassing applications such as product tracking or logistics.

All companies have been expanding their product range for years and, more specifically, over the last few months. They have either developed and manufactured new RFID systems or bought tags from other suppliers. Companies are positioning themselves for the awaited RFID battle. Yet, nearly everyone faces the problem of uncertainty with regard to the competition—the size of the sales forces, the marketing strategies, and frequencies to be offered in the future remain unknown. Therefore, it is nearly impossible to design an efficient sales strategy. The result: suppliers in France are still facing uncharted paths due to the lack of competitor awareness.

In their report, *The French Market for RFID Tags and Readers*, Research Solutions Ltd. (www.research-solutions.co.uk), a European business consultancy, have compiled a detailed analysis of the French market for RFID tags and readers. Over 40 suppliers were interviewed. Key findings include:

1. Nearly all companies have added new tags to their product ranges over the last few months, and a great number of them are about to expand their portfolio by the end of the year.
2. A good number of companies—mainly from the USA—have entered the market during the last few months but are scarcely known, not having yet sold RFID products.
3. A few suppliers are engaged in vast recruitment programs in order to boost their sales forces. MRF

CONTRACTS

Northrop Grumman Corp.—Has been selected by the US Air Force to provide technical services in support of the transformation of its logistics combat support systems. The Air Force transformation goals are to improve the transmission of accurate, reliable, and readily accessible logistics information to warfighters in support of combat initiatives.

Northrop Grumman's Information Technology sector will share in task orders valued at up to $498 million over five years. The contract is administered by the Materiel Systems Group at Wright-Patterson Air Force Base, Ohio.

The scope of the contract includes software development, implementation of commercial off-the-shelf products (COTS), and enterprise-resource-planning (ERP) tools to update the Air Force's combat support system. Northrop Grumman IT will also compete to administer the transition of logistics, finance, procurement, and personnel to COTS and ERP tools in an effort to reduce long-term maintenance costs and increase system performance.

TECOM Industries, Inc.—Announced that TECOM was awarded a contract for delivery of 28,000 Iridium retractable mobile antennas to meet the increasing demands on Iridium's Mobile Satellite Communication worldwide. This is a follow-on contract to the previous award for 30,000 Iridium antennas let in June of 2003.

FRESH STARTS

Hittite Microwave Corp.—Has appointed a new sales representative firm to serve customers in Australia and New Zealand. ASD Technology Pty Ltd., headquartered in Sydney, Australia, offers products and solutions covering areas of RF/microwave, satellite communication, fiber optics, and electronics as well as many other advanced technological products.

ASD Technology can be contacted by phone at +61 2 9884 7486, via fax at +61 2 8080 8366, or by e-mail at info@asdtech.com.au. Their website is located at www.asdtech.com.au.

Valpey-Fisher Corp.—Announced the addition of SM Electronic Technologies Pvt Ltd. of Bangalore, India to the Valpey-Fisher global distribution and rep network as the exclusive authorized distributor for all Valpey Fisher Corp. product lines to the Indian market.

Aeroflex, Inc.—Launched a new e-commerce store at www.aeroflexstore.com. The site features the company's new PXI 3000 Series, a PXI-based modular test suite for mobile-phone and general-purpose wireless test, and allows customers to buy the modules, options, and warranties online.

Radstone Technology—Has agreed to acquire Octec Ltd., a privately held UK company that designs and markets rugged, real-time, image-processing, and video-tracking equipment to defense and aerospace customers.

Teledyne Technologies, Inc. and Celeritek, Inc.—Jointly announced that Teledyne, through its subsidiary Teledyne Wireless, Inc., has entered into an agreement to acquire Celeritek's defense electronics business for $33.0 million in cash.

Celeritek's defense electronics division had sales of $19.7 million for its fiscal year ended March 31, 2004. Teledyne Technologies expects the acquisition of Celeritek's defense electronics division to be neutral to earnings in 2004. If completed, the acquired business would be operated as part of Teledyne Microwave.

Polytec PI, Inc.—Has reorganzied to become Polytec, Inc. The reorganization completes the separation of Polytec and PI's North American operations. The separation strategy was implemented to better serve Polytec and PI customers in North America. The stateside change mirrors the physical and financial separation in 2002 of the parent businesses in Germany, Polytec GmbH and Physik Instrumente GmbH (PI).

TechnoConcepts, Inc.—Announced that the company has been issued Patent No. 6,748,025 from the US Patent and Trademark Office.

This patent, which covers 19 different claims that have been allowed by the Patent Office, is for the conversion of RF signals directly into high-speed digital data (R/D) streams, which are then sorted and demodulated with digital signal processing.

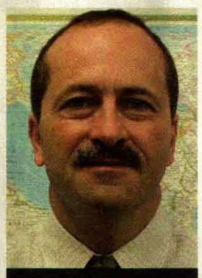
Modelithics, Inc.—Announced the appointment of Tech-Inter, S.A. (www.tech-inter.fr) of Maurepas, France, as a reseller for its EDA RF/microwave model library software, measurement, and modeling services in France.

Modelithics has also signed Sematron Italia (www.sematronitalia.it), with offices in Rome and Milan, as a reseller for its products and services in Italy.

LPKF Laser & Electronics AG and BASF AG—Have signed a know-how and licensing agreement. With this agreement, BASF has modified a range of high-performance plastics (PA, POM, PES, & PSU) to contain a special laser-sensitive metal organic complex used for LPKF's proprietary laser-based production process of Molded Interconnect Devices (MIDs).

Wireless Valley Communications, Inc.—Announced a new distribution relationship with TESSCO Technologies, Inc. Through this agreement, value-added resellers and system integrators will now have access to Wireless Valley's LANPlanner® for in-building design and management, as well as the recently launched LANPlanner® SE for small businesses.

Cypress Semiconductor Corp. and Atmel Corp.—Jointly announced that Atmel will manufacture and sell chips based on Cypress' 2.4-GHz WirelessUSB™ technology. WirelessUSB chips are currently used in low-data-rate wireless devices, such as PC keyboards, mice, and video-game controllers, and are being designed into a wide array of applications, including remote controls, toys, and sensors. MRF



TAFLER

CPI Taps Tafler As Satcom Division President/GM

Communications & Power Industries, Inc. (CPI) has appointed ANDY TAFLER to the position of president and general manager of the company's Satcom Division. Tafler was most recently the Satcom Division's vice president of operations.

Hittite Microwave Corp.—THOMAS HWANG to director of sales; formerly manager for Asia sales.

Fujitsu Microelectronics Europe GmbH—SHIMPEI HIRATA to president; formerly marketing strategy planning director at Electronic Devices.

SV Microwave, Inc.—ALAN LAFLIN to western regional sales manager; formerly held a senior sales management position at Tru-Connector.

Texas Instruments—JULIE ENGLAND to general manager of the radio-frequency-identification (RFID) Systems group, a business unit of Texas Instruments Sensors & Controls Division; formerly general manager of TI's Sun business within the Semiconductor group.

American Berylia, Inc.—KIRK KEITHLEY to COO; formerly president and general manager at Brush Ceramic Products.

Aeroflex/Weinschel, Inc.—MARK DARROW to vice president of sales and marketing; formerly vice president of sales for OEwaves, Inc.

Centurion Wireless Technologies, Inc.—MARK COCKSON to director of sales for Land Mobile Products; formerly director of strategic business development.

ITT Industries, Inc.—STEVEN R. LORANGER to president and CEO, also to serve on the board of directors; formerly executive vice president and COO of Textron, Inc.

Willtek Communications—FRANCIS PAEZ to vice president of sales for the Americas region; formerly director of sales at Tektronix, Inc.

DayStar Technologies, Inc.—DR. STEVEN ARAGON to vice president of engineering; formerly program manager of DC Plasma Power Products at Advanced Energy Industries. Also, JON SHARP to director of operations; formerly product manager.

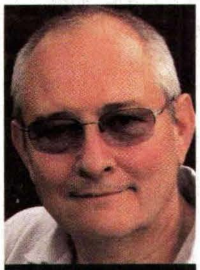
SRS Labs, Inc.—CAROL MILTNER to the board of directors; continues as CEO of Positive Impact.

Video Internet Broadcasting Corp. (VIB TV)—JON MOORE, PE to chief technical officer; formerly principal engineer with the Grant County Public Utility District.

Nanotron Technologies—ZBIGNIEW IANELLI to managing director; formerly chief technology officer. Also, MANFRED KOSLAR to the advisory board; formerly managing director.

Maury Microwave Corp.—DR. ALI BOUDIAF to product manager for the solid-state tuner-based noise parameter and load-pull product line; formerly R&D product manager at ACCO-USA.

Indium Corp.—PAUL SALMON to director of marketing for Indium of Europe; formerly worked in the fields of soldering products and sales-channel development as well as strategic marketing of consumable products across the European Continent.

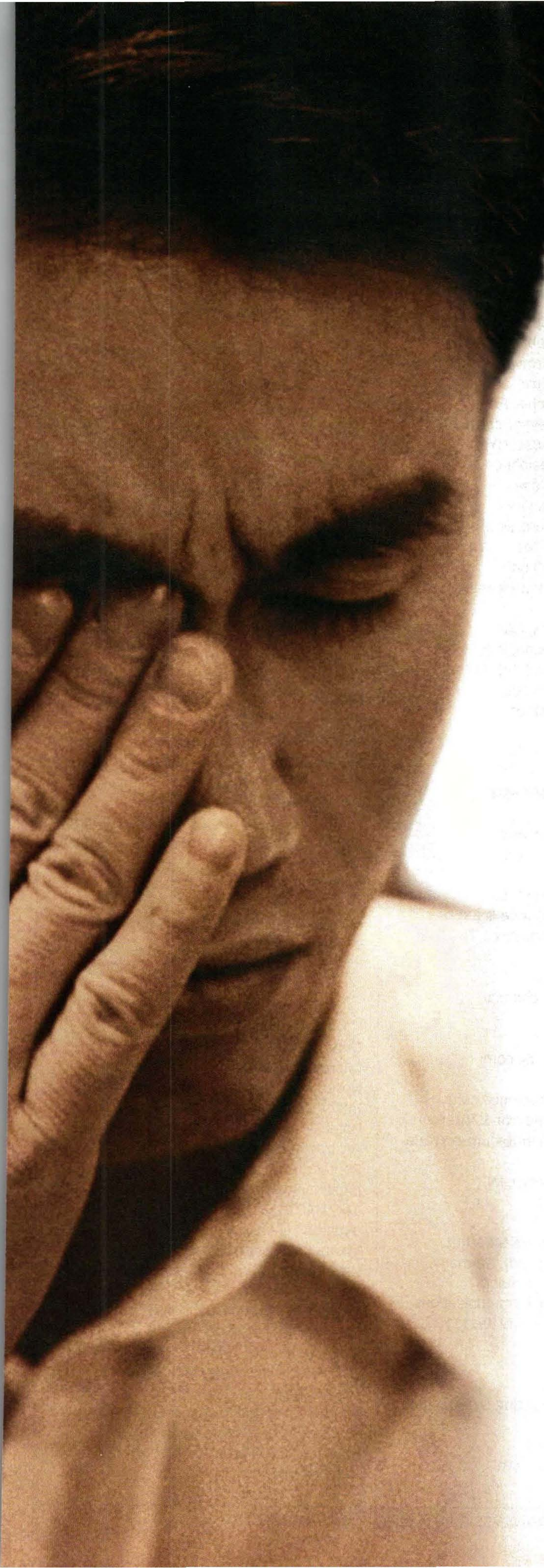


SALMON

GHARA

Sabritec—MIKE GHARA to director of engineering; formerly director of engineering for Delphi Connection Systems.

AMI Semiconductor—TONY LIANG to vice president of sales for the Asia Pacific market; formerly Asian business manager at Cygnal Integrated Products. MRF



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▸MEETINGS

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Internet: www.intel.com/idf/us

Portable Power Conference & Expo
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The Argent Hotel
Hosted by IDG World Expo
For further information, contact:
Jennifer LaFond
(508) 424-4809
e-mail: jennifer_lafond@idg.com
Internet:
www.portablepowerconference.com

37th Annual IICIT Connector & Interconnection Technology Symposium & Trade Show
September 13-15 (Dearborn, MI)
Hyatt Regency Dearborn
Internet: www.iicit.org

CST European User Group Meeting
September 23-24 (Darmstadt, Germany)
For further information, contact:
Ruth Jackson, Marketing Communications
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ASTM Committee B02 on Nonferrous Metals and Alloys
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For further information, contact Jeffrey Adkins, ASTM — (610) 832-9738
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ASTM Committee B10 on Reactive and Refractory Metals and Alloys
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Internet: www.astm.org/COMMIT/B10.htm

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Modeling RF MEMS With Artificial Neural Networks

ACCURATE MODELING OF RF MEMS has been attempted with a variety of full-wave numerical methods, including boundary-element (BE), finite-element (FE), and finite-difference time-domain (FDTD) approaches. While accurate, these techniques are generally limited to a single analysis for a specific structure, and require long computation times when a number of simulations are run with different mesh properties. For this reason, Yongjae Lee and associates from the Center for Advances Manufacturing and Packaging of Microwave, Optical, and Digital Electronics and Department of Electrical and Computer Engineering of the University of Colorado at Boulder (Boulder, CO) explored the use of artificial neural network (ANN) modeling of MEMS resonators. The model is constructed through the use of the neural network design (NND) toolbox in MATLAB from The MathWorks (Natick, MA). The inputs to the ANN model are the geometrical parameters of the resonator (length, width, resonator-to-electrode gap, etc.) while the outputs are resonant frequency, dynamic and statis output currents, input impedance, and beam displacement. The approach used for the resonator can also be applied to MEMS-based circuits and devices such as switches, accelerometers, and micromirrors.

The modeled resonator is composed of a fixed beam suspended over an underlying electrode. By combining analyses with a circuit simulator, full-wave simulator, and the ANN approach, a model was developed that could be integrated within the Advanced Design System (ADS) simulator from Agilent Technologies (Santa Rosa, CA) for more detailed system-level analysis and design. In addition to cutting simulation cost and time, the new model aids in circuit-level tuning and optimization. See"Artificial Neural Network Modeling of RF MEMS Resonators," *RF and Microwave Computer-Aided Engineering,* July 2004, Vol. 14, No. 4, p. 302.

CMOS Forms One-Chip 10-Gb/s SONET Transceiver

SONET COMMUNICATIONS SYSTEMS operating at 10 Gb/s usually employ separate transmitters and receivers. Researchers Harish Muthali, Thomas P. Thomas, and Ian Young of the Portland Technology Department of Intel Corp. (Hillsboro, OR) have proposed a single-chip SONET OC-192 transceiver solution with outstanding performance to replace the separate chips. The transceiver chip consists of a receiver and transmitter. An optical signal is fed into the receiver after being converted to an electrical signal by means of a transimpedance amplifier (TIA). The receiver, which includes a 10-Gb/s limiting input amplifier, extracts a 10-GHz clock from the nonreturn-to-zero (NRZ) data stream and deserializes this into 16 parallel data channels at a data rate of 622 Mb/s. The framer performs forward-error-correction (FER) encoding and decoding on the data input. The transmitter, which includes a 10-Gb/s clock multiplier unit, receives 16 parallel bits at 622 Mb/s from the framer. These are serialized and retimed with a precise 10-GHz clock. The transmitter's serial output modulates a laser diode which generates an optical signal to be sent along a fiber.

The single-chip transceiver was fabricated with 90-nm CMOS process technology and packaged in a flip-chip ball-grid-array (FCBGA) housing. The chip has supplies of +1.2 VDC for the core logic and +1.8 VDC for the analog and LVDS circuits. The total power dissipation for the transceiver is 1.65 W, which the researchers claim could be reduced further. See "A CMOS 10-Gb/s SOMET Transceiver," *IEEE Journal of Solid-State Circuits,* July 2004, Vol. 39, No. 7, p. 1026.

Antennas Transmit Medium-Wave Signals

LOW-PROFILE ANTENNAS have great appeal in many areas in which radio coverage must be provided unobtrusively. To this end, Clarence Beverage, long-time president of Communications Technologies, Inc. (Marlton, NJ), has performed analysis on two different types of antenna for medium-wave transmissions. The first is a minimum reactance antenna and the second is a Parasol antenna, which is an advanced development of the earlier Umbrella antenna design. Both types of antennas are intended for use in the 535-to-1705-kHz medium-wave broadcast band. The author performed numerous measurements, using an open, flat field in New Jersey as the antenna range. A total of eight different antenna configurations were assembled on site and tested, and compared to a quarter-wave reference antenna. One of the Parasol designs offered the best overall performance, although several offered size advantages compared to the reference. See "Compact Medium Wave Transmitting Antennas," *IEEE Transactions on Broadcasting,* June 2004, Vol. 50, No. 2, p. 142.

Optically Sculpt UWB Waveforms

The dispersive effects of optical fibers can be used to optically shape ultra-wideband waveforms that exhibit high stability without the limitations of electronic arbitrary waveform generators.

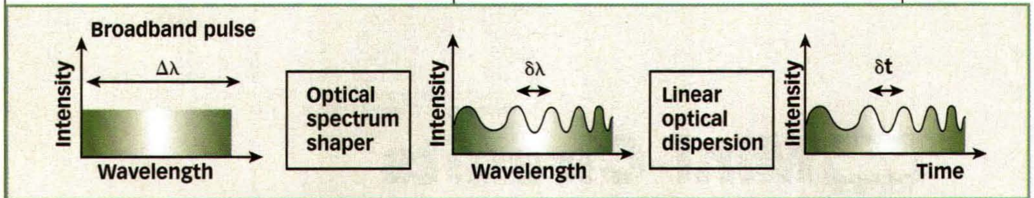
BAHRAM JALALI
Professor
JASON CHOU
YAN HAN
Students
UCLA Optoelectronics Circuits and Systems Laboratory, Department of Electrical Engineering, Box 951594, 68-109 Engr IV, University of California at Los Angeles, Los Angeles, CA 90095-1594; (310) 825-9655, FAX: (310) 206-2239, e-mail: jalali@ucla.edu, Internet: www.ee.ucla.edu/~oecs/.

Ultrawideband (UWB) and optical waveforms with arbitrary and wideband modulation can be generated by sculpting the spectrum of a broadband optical pulse and subjecting it to linear dispersion. The technique can be visualized as a two-step process. First, the optical spectrum is shaped according to the desired temporal waveform. The spectrum is then mapped into time by passing the waveform through a linearly dispersive element, such as an optical fiber. Adaptive computer control is necessary to mitigate the nonideal features inherent in the optical source and in the spectrum sculpting process.

The ability to generate high frequency and complex waveforms is central to many commercial and military applications. In communication receiver testing, for example, an arbitrary waveform generator (AWG) is used to emulate a channel-impaired received signal. The military relies on sophisticated and agile RF waveforms in applications such as low-probability-of-intercept (LPI) radar.[1] Hybrid LIDAR-RADAR systems require a wideband amplitude-modulated optical carrier in order to attain high-range resolution.[2]

The development of electronic AWGs is hindered by the limited speed and dynamic range of digital-to-analog (DAC) technology. Currently, state-of-the-art commercial systems are limited to less than 2 GHz analog bandwidth and sampling rates of approximately 4 GSamples/s.[3] The all-optical approach to generating UWB RF waveforms introduced here does not rely on electronic switching and so is free of the limitations of DAC technology. Implemented using presently available commercial off-the-shelf components, the system would have a bandwidth of 60 GHz.[4]

Photonic methods in generating microwave and millimeter-wave signals have largely been limited to coherent techniques. In one approach, two modes of an optical frequency comb generator are filtered and mixed at a photodetector to generate a 60-GHz signal that is equal to the difference frequency between the two optical signal components.[5] Multiple 60-GHz signals have also been



1. This conceptual diagram illustrates the process of (optical) wavelength-to-time conversion through a linearly dispersive element.

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reported by mixing pairs of coherent light waves.[6] In a multiple-source approach, a 36-GHz carrier was demonstrated by optical heterodyning using an optical injection phase-locked loop.[7] When the beating technique is combined with a programmable amplitude/phase filter, arbitrarily shaped optical pulse trains can be generated by Fourier spectrum synthesis.[8] Unfortunately, waveforms generated by means of coherent optical techniques lack phase stability and, thus, signal fidelity.

An alternative approach to coherent optical techniques is shown in **Fig. 1.**[9] The spectrum of a wideband optical pulse is sculpted by an optical filter and then passed through an optically dispersive medium such as an optical fiber. The dispersive medium exhibits a group velocity that is linearly dependent on the optical wavelength. Hence, dispersion performs wavelength-to-time mapping converting the spectral modulation to a temporal modulation. In other words, the intensity of the (broadened) optical pulse will acquire a temporal modulation waveform that is identical to the waveform imposed on the optical spectrum. Any arbitrary temporal waveform can be generated by properly shaping the spectrum of the broadband optical source. For a given spectral waveform, the frequency of the temporal waveform is determined by the amount of dispersion.

To quantify the wavelength-to-time mapping, consider a simple example. Assume that the total optical bandwidth is $\Delta\lambda$ = 100 nm and the period of spectrum modulation is δt = 0.1 nm (Fig. 1). If 10 km of standard single-mode fiber (SMF) is used as the dispersive medium, then the total dispersion is D = 170 ps/nm. After propagation through this fiber, the resulting pulse-modulated RF waveform will be 17 ns long ($D\Delta\lambda$) and will have a modulation frequency of 59 GHz [$(D\Delta\lambda)^{-1}$]. Implemented when using presently available commercial components, the system's bandwidth will be limited by the photodetector. As previously mentioned, this limit is currently 60 GHz.[4] A useful figure of merit for the dispersive element would be its dispersion-to-loss ratio. From this point of view, a

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MCA1-60MH	13	1600-6000	6.4	27	8.95
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dispersion compensating fiber (DCF) is preferred over SMF as the dispersive medium since it offers a two times higher dispersion ratio.

Modulation of the optical spectrum can be achieved using a variety of optical filtering approaches, including the two approaches shown in **Fig. 2**. In Fig. 2a, the different spectral components of the optical pulse are separated and imaged onto a liquid-crystal spatial light modulator (SLM). Since the transmission of each SLM pixel depends on the applied pixel voltage, the spectrum can be shaped to any desired waveform. After the SLM, the spatially dispersed beam is combined and focused into the output optical fiber. The setups in Figs. 2b and 2c make use of a particular optical filter called an arrayed waveguide grating (WG). This is an integrated optics device commonly used as a wavelength multiplexer/demultiplexer in telecommunication networks.[10] It can be thought of as a frequency-scanned phased array with the distinction that, here, the array has a curved geometry resulting in the focusing of the transmitted beam. In Fig. 2b, the first WG separates the individual wavelength components that are subsequently shaped (by optical attenuators) and delayed before being combined in the second WG. In Fig. 2b, the same function is performed with a single WG, by recognizing its symmetry properties.[11,12]

In the experiments described below, an SLM array was used to shape the spectrum of the broadband pulse. SLMs have been used by Weiner *et al.* for femtosecond optical pulse shaping via spectral phase control.[13] Their approach employed a coherent Fourier transform process where a temporal waveform was synthesized through manual control of optical phase. The approach described here is incoherent. Instead of performing a Fourier transform, the desired temporal waveform is created by direct wavelength-to-time mapping.

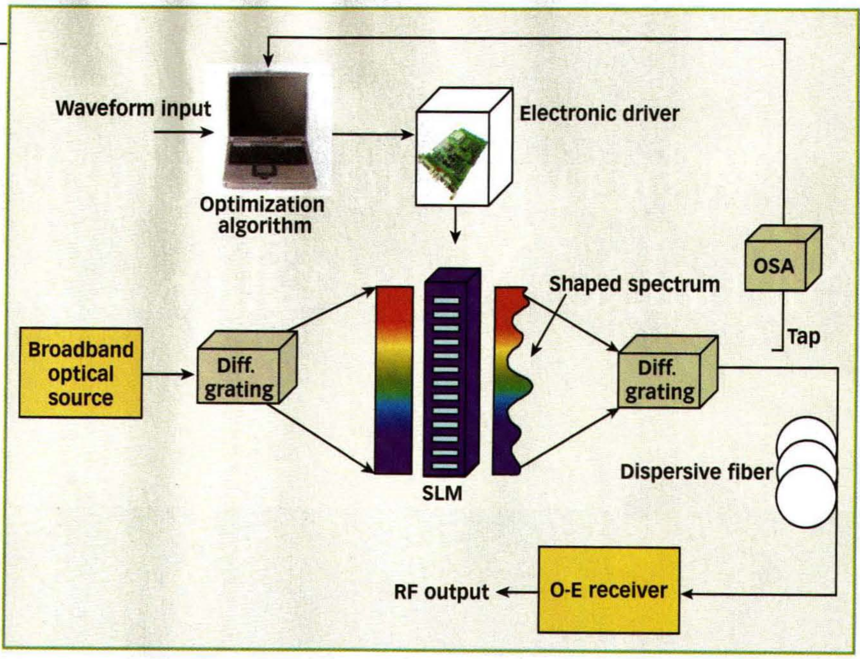
A broadband optical source is produced by amplifying the output of a mode-locked laser and passing it through a specialty fiber called a super-continuum (SC) fiber.[14] Optical nonlinearities in the SC fiber cause broadening of the optical spectrum to over 100 nm. Next, a spatial light modulator filters and shapes the spectra according to the desired optical waveform. In the current experiments, a 4-f grating and lens apparatus were used such that each wavelength will be focused and incident normal onto the SLM plane. The grating has 1000 lines/mm while the lens focal length is 20 cm. The distances between gratings and lenses are set for zero net temporal dispersion. Two high-extinction-rate polarizers are placed in parallel before and after the liquid crystal to achieve ampli-

tude modulation (AM). The pixels are independently controlled by a computer-operated electronic driver, which manipulates the voltage (and thus the attenuation) to gray-scale accuracy. A maximum optical dynamic range of 30 dB optical (60 dB electrical) can be achieved for AM. This can be doubled by cascading two SLMs in series, with a small increase in optical loss and system complexity. Finally, the beam is coupled back into single-mode fiber through an identical optical path.

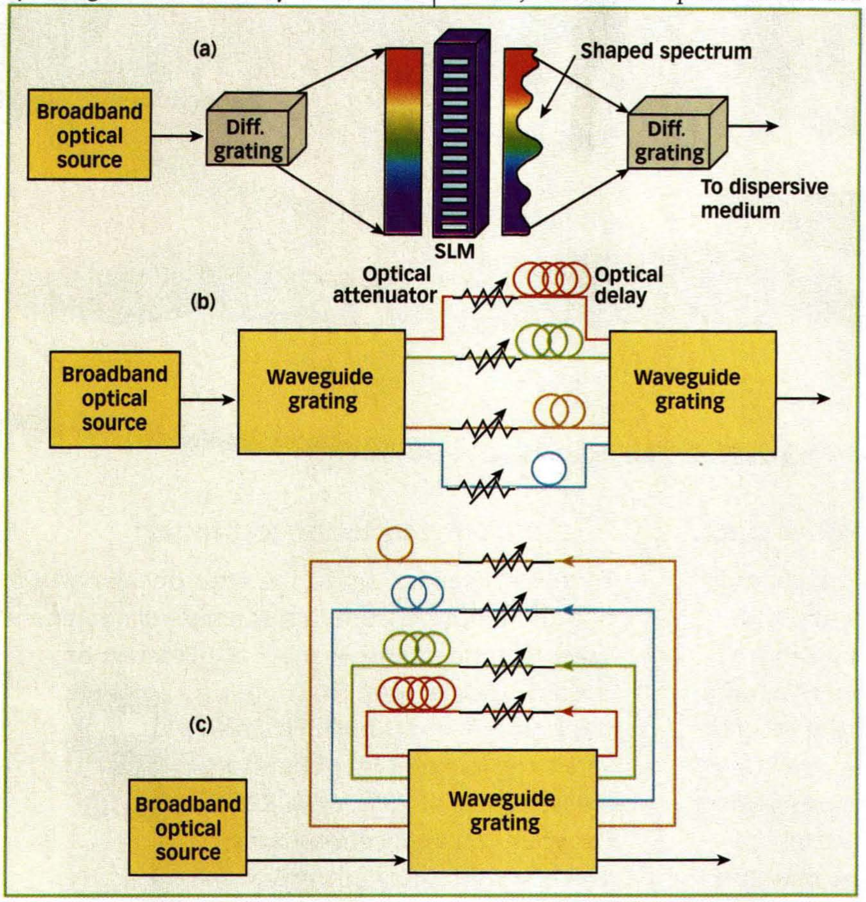
The experiment constructed at UCLA has an optical insertion loss of 6.2 dB and a 3-dB spectral passband of 9.5 nm and 15-dB spectral passband of 20 nm. The system uses 20 nm of optical bandwidth, which corresponds to 110 SLM pixels available for waveform generation. A length of Corning SMF-28 fiber having a dispersion parameter D = 17 ps/nm-km is used for wavelength-to-time mapping. The system generates arbitrary waveforms at the repetition rate of the optical source (20 MHz in this case). The time aperture (T) of the waveform is related directly to the length (L) of optical fiber by $T = D\Delta\lambda L$, with $\Delta\lambda$ the optical bandwidth (20 nm).

The maximum frequency that can be generated for a given fiber length L is determined by the Nyquist requirement of $f_{max} = 1/(2D\delta\lambda L)$, with $\delta\lambda = 0.625$ nm = the filter spectral resolution. The spectral resolution is the ratio of the spot size at the pixel plane to the spatial dispersion of the grating lens.

In practice, the process of wavelength-to-time mapping is not ideal because of the following two issues. First, the finite focal size spanning multiple pixels removes the 1:1 correspondence between wavelength and pixel. Second, the broadband spectrum is not uniform resulting in the distortion of the desired waveform. Because of these issues, the control voltage for the SLM array cannot be a simple replica of the desired waveform. To create a practical and robust system, an adaptive algorithm was developed to ensure correct wavelength-to-time mapping. The desired waveform serves as the input to an adaptive algorithm running on a laptop computer. Before photodetection, a portion of the optical signal is coupled out and into an optical spectrum analyzer (OSA) as illustrated in **Fig. 3.** A feedback loop is made such that a least-squares (LS) algorithm iteratively adjusts the pixel voltages until the input waveform matches the measured spectrum. The error is reduced until a user-specified tolerance is reached. This solution is implemented using the LabVIEW data acquisition and pro-

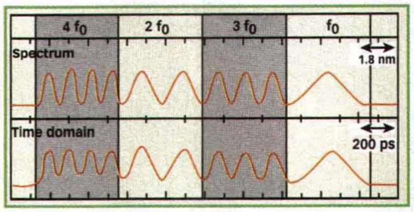


3. This block diagram shows the photonic arbitrary waveform generator.



2. These three approaches offer practical methods for sculpting the optical spectrum: (a) using two diffraction gratings plus a liquid-crystal spatial light modulator (SLM) [or alternatively, an optical arrayed waveguide grating (WG)]; (b) two back-to-back gratings; and (c) a single grating in the feedback configuration.[9,11,12]

gramming tool from National Instruments (Austin, TX). Once a desired waveform is generated, the pixel voltage information can be saved and used to generate the same waveform at a later time. The algorithm plays an important role since complex waveforms cannot be generated trivially by manual manipulation of the pixel voltages.



4. This UWB frequency-hopped CDMA waveform hops from 2 GHz to 8 GHz in 2-GHz increments. The top trace shows the optical spectrum measured by the OSA and the lower trace shows the temporal waveform measured by an oscilloscope.

Figure 4 shows UWB frequency-hopped waveforms using 5 km of fiber. The frequency hops between 2 and 8 GHz in increments of 2 GHz. The system generates finite-length replicas of arbitrary waveforms at the repetition rate of the supercontinuum source. The repetition rate can be easily increased by using a laser with higher repetition rate, for example, a harmonically mode-locked fiber laser or a semiconductor mode-locked laser. The use of actively mode-locked lasers will afford much higher pulse-to-pulse stability.[15] MRF

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REFERENCES

1. George W. Stimson, *Introduction to Airborne Radar*, 2nd ed., SciTech Publishing, Inc., Raleigh, NC, 1998.

2. L. Mullen, A. Vierina, P. Herczfeld, and V. Contarino, "Application of RADAR Technology to Aerial LIDAR Systems for Enhancement of Shallow Underwater Target Detection," *IEEE Transactions on Microwave Theory and Techniques*, September 1995, Vol. 43, No. 9, pp. 2370-2377.

3. AWG710 Arbitrary Waveform Generator data sheets, Tektronix, Inc., Beaverton, OR, www.tek.com.

4. Model DSC10ER PIN diode data sheets, Discovery Semiconductor, Ewing, NJ, www.chipsat.com.

5. S. Fukushima, C.F.C. Silva, Y. Muramoto, and A.J. Seeds, "Optoelectronic synthesis of milliwatt-level multi-octave millimeter-wave signals using an optical frequency comb generator and a unitraveling-carrier photodiode," *IEEE Photonics Technology Letters*, July 2001, Vol. 13, No. 7, pp. 720-722.

6. T. Kuri and K. Kitayama, "60 GHz band millimeter-wave signal generation and transport over optical frequency division multiplexing networks," *Electronics Letters*, November 1996, Vol. 32, No. 23, pp. 2158-2159.

7. L.A. Johansson, A.J. Seeds, "36-GHz 140-Mb/s radio-over-fiber transmission using an optical injection phase-lock loop source," *IEEE Photonics Technology Letters*, August 2001, Vol. 13, No. 8.

8. S. Osawa, N. Wada, K. Kitayama, and W. Chujo, "Arbitrarily-shaped optical pulse train synthesis using weight/phase programmable 32-tapped delay line waveguide filter," *Electronics Letters*, October 2001, Vol. 37, No. 22.

9. B. Jalali and P. Kelkar, "Method and Apparatus for Arbitrary Waveform Generation Using Photonics," Patent Pending.

10. Rajiv Ramaswamy and Kumar N. Sivarajan, *Optical Networks, A Practical Perspective*, 2nd ed., Morgan Kaufman Publishing, San Francisco, CA, 2002, Chap. 3.

11. B. Jalali and S. Yegnanarayanan, "Method and Apparatus for a Wavelength Selective True-Time Delay for an Optically Controlled Device," United States Patent No. 5,793,907, 1998.

12. B. Jalali, P. Kelkar, and V. Saxena, Photonic arbitrary waveform generator, LEOS 2001. 14th Annual Meeting of the IEEE Lasers and Electro-Optics Society (Catalog No. 01CH37242), Piscataway, NJ, 2001, Vol. 1, pp. 253-254.

13. A.M. Weiner, "Femtosecond optical pulse shaping and processing," *Progress in Quantum Electronics*, 1995, Vol. 19, pp. 1-237.

14. O. Boyraz, J. Kim, M.N. Islam, F. Coppinger, and B. Jalali, "10 Gb/s multiple wavelength, coherent short pulse source based on spectral carving of supercontinuum generated in fibers," *Journal of Lightwave Technology*, December 2000, Vol. 18, No. 12, pp. 2167-2175.

15. W. Ng, R. Stephens, D. Persechini, and K.V. Reddy, "Ultra-low jitter mode locking of Er-fiber laser at 10 GHz and its application in photonic analog-to-digital conversion," *Technical Digest of the International Topical Meeting on Microwave Photonics*, IEEE MWP 2000 (Catalog No. 00EX430), Oxford, England, September 11-13, 2000.

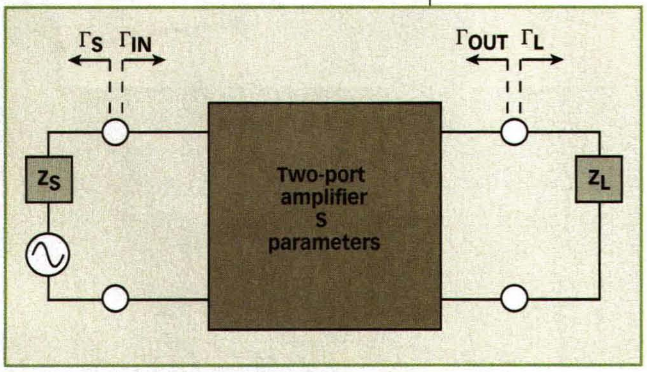
Ensure Stability In Amplifier Designs

Knowledge of stability circles and S-parameters can help to develop input and output matching circuits that deliver stable amplifier performance at a desired frequency.

JOSEPH F. WHITE
President
JFW Technology, Inc., e-mail: jwhite@ieee.org.

Amplifiers can be designed as simply as by installing a transistor in a 50-Ω system. As was shown last month in the first installment of this article series, in this simple case, the gain at each frequency was just the square of the magnitude of S_{21} as listed in the S parameter table for the transistor. Additional gain could be obtained at any given frequency for which the transistor has gain by adding matching circuits at the input and/or at the output. This second part of the article series will examine the stability of a transistor amplifier and how to apply stabilizing elements to obtain it.

Thus far, the transistor has been treated as a *unilateral* device, with signals assumed to pass from the input to the output but not in the reverse direction. Making the unilateral assumption is equivalent to assuming that S_{12} is zero. The S_{12} parameter provides the feedback term by which power from the output circuit (which may be relatively high due to the transistor's amplification) can feed back to the input. When it does so, it may combine with reflections already present at the input to produce an effective S_{11} whose magnitude exceeds unity. This corresponds to reflection gain, and a transistor amplifier that can experience this gain, is termed conditionally unstable, the conditions being certain combination(s) of load impedance, S_{12} and S_{11} to produce self-oscillation (instability).



1. This two-port network is represented by S-parameters embedded between source and load of general complex reflection coefficients.

In the 2N6679A transistor amplifier example, the magnitudes of S_{11} and S_{22} of the transistor are less than one

Table 1: Stability criteria for the 2N6679A transistor

FREQ (MHz)	K	B1
0	0.195	0.203
500	0.684	1.153
1000	0.875	1.23
1500	0.964	1.219
2000	0.962	1.231
2500	0.972	1.205
3000	1.755	1.119
3500	0.913	1.117
4000	0.863	1.086
4500	0.842	1.051
5000	0.663	1.009
5500	0.611	0.975
6000	0.526	0.902
6500	0.498	0.879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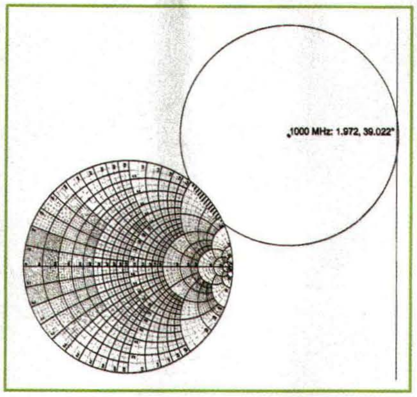
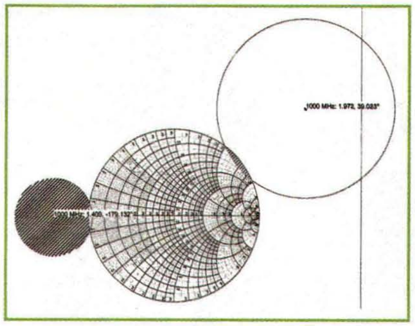


2. This plot shows the load instability circle for the 2N6679A transistor from Motorola at 1 GHz.



3. This plot shows the source instability circle (at left) and load instability circle (at right) for the 2N6679A transistor at 1 GHz.

for all frequencies. This means that the transistor is stable when embedded between 50-Ω source and load, and it will not oscillate. However, this is not considered unconditional stability, because with different source and load impedances the amplifier might break into oscillation. A properly designed (stabilized) amplifier will not oscillate no matter what passive source and load impedances are presented to it, including short or open circuits of any phase.

Because the value of S_{12} for practical transistors is not zero, a signal path exists from the output (where power levels are higher due to the device's gain) to the input **(Fig. 1)**. It is possible that for certain values of load reflection coefficient, Γ_L, the input reflection coefficient, Γ_{IN}, can exceed unity, turning the circuit into a reflection amplifier at the input. Similarly, certain values of source reflection coefficient, Γ_S, at the input might cause the output reflection coefficient, Γ_{OUT}, to exceed unity magnitude. If either or both of these conditions can occur at any frequency, the circuit is said to be only conditionally stable, or equivalently, potentially unstable.

The boundary line between stable and unstable operation at the input is the $|\Gamma_{IN}| = 1$ circle centered at the origin of the Smith Chart. The contour of values for Γ_L (also a circle) that produces a unity magnitude reflection coefficient at the input is called the input stability circle (shown in **Fig. 2** at 1 GHz for the 2N6679A transistor). The input stability circle represents a set of load reflection coefficients that cause the input reflection coefficient to have a

Table 2: Calculated K factor for the stabilized 2N6679A transistor

	FREQ (MHz)	K	B1
1	100	6.093	0.81
2	200	2.008	0.875
3	300	1.237	0.965
4	400	1.074	1.076
5	500	1.221	1.186
6	600	1.081	1.216
7	700	1.02	1.23
8	800	1.015	1.232
9	900	1.059	1.224
10	1000	1.165	1.204
11	1100	1.173	1.162
12	1200	1.222	1.105
13	1300	1.34	1.031
14	1400	1.608	0.934
15	1500	2.339	0.817
16	1600	5.172	0.709
17	1700	18.87	0.712
18	1800	5.059	0.925
19	1900	2.247	1.184
20	2000	1.608	1.328

$$\Gamma_L = \frac{\Gamma_{IN} - S_{11}}{S_{22}\,\Gamma_{IN} - \Delta} \quad \text{where } \Delta = S_{11}S_{22} - S_{12}S_{21} \qquad (1)$$

unity magnitude. Also note that the input stability circle represents a boundary, on one side of which $|\Gamma_{IN}| < 1$ resulting in load impedances that result in stable operation and on the other side of which $|\Gamma_{IN}| > 1$, corresponding to load impedances that produce potential instability.

The Γ_L values are related to the Γ_{IN} values according to Eq. 1, which is called a mapping function because it maps a Γ_{IN} contour into a Γ_L contour (pp. 140-145 in ref. 1). This function maps the $|\Gamma_{IN}| = 1$ function into a Γ_L contour (in this case, a circle) to a circle:

SEE EQ. 1 IN BOX ABOVE RIGHT

Inserting the condition $|\Gamma_{IN}| = 1$ into Eq. 1 creates a mapping of the $|\Gamma_{IN}| = 1$ circle into the input stability circle in the Γ_L plane with center at the

$$C_L = \frac{S_{22}^* - \Delta^* S_{11}}{|S_{22}|^2 - |\Delta|^2} \qquad (2)$$

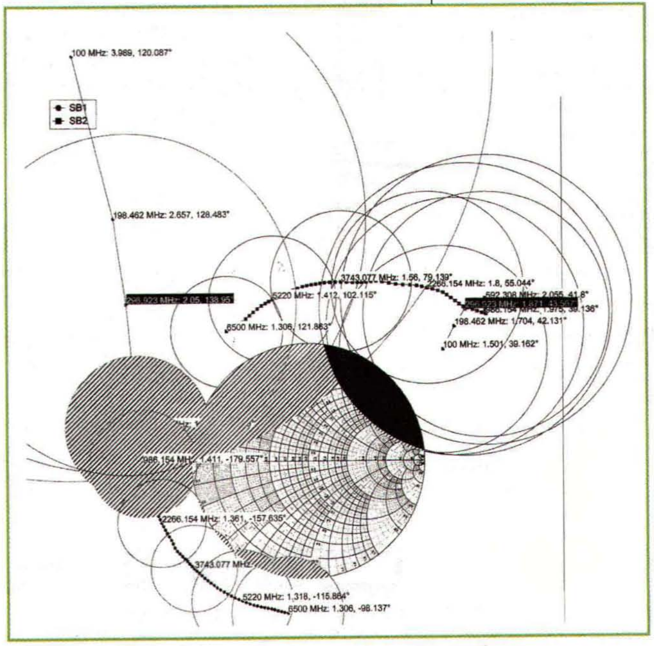
and a radius of

$$R_L = \left| \frac{S_{12}\,S_{21}}{|S_{22}|^2 - |\Delta|^2} \right| \qquad (3)$$

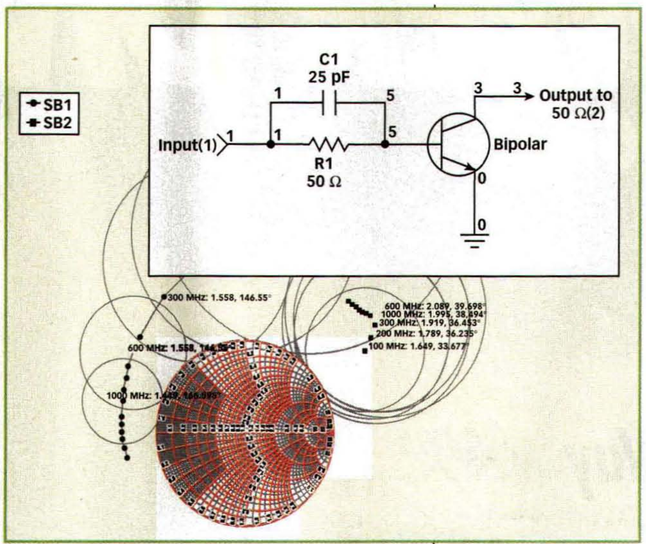
The input stability circle is also called the load instability circle, because it describes the Γ_L values that border on causing instability, that is which result in $|\Gamma_{IN}| = 1$. The input stability circle will be referred to as the load instability circle because this nomenclature places the focus on the load impedances that cause instability.

The circle intersects and intrudes into the unity radius area of the Smith Chart. Thus, the transistor is potentially unstable for certain passive load impedances bounded by the circle. The circle is the boundary of the unstable impedances. Since it is only the boundary, when the circle is first plotted, it is not certain whether the unstable load impedances are those inside or outside the circle. In the example of Fig. 2, it would seem highly likely that the unstable points are inside the circle, since most of the circle is in the negative resistance domain of the Smith Chart. However, there are instances in which the entire circle may lie within the unity-radius, passive-impedance portion of the Smith Chart. A means for determining which side of the boundary represents the unstable impedances is needed. The determination is facilitated by the availability of the S-parameters, which apply with a known load, usually 50 Ω.

To determine whether the unstable load impedances are inside or outside the circle, consider the "easy point," S_{11}. From the S-parameter file for the 2N5579A transistor, it is known that when the transistor is loaded with 50 Ω, the center of the Smith Chart, $|S_{11}| < 1$. Therefore, the center of the Smith Chart is a stable load point. Since the center of



4. The source and load instability circles are shown here for a band of frequencies from 100 to 6500 MHz.



5. These revised instability circles result when resistance damping is placed in the base lead of the 2N6679A transistor.

the Smith Chart is outside the load instability circle, all points outside the circle are stable, and points inside the circle in Fig. 2 are the unstable loads.

Figure 2 also shows that high inductive load impedances at the output can cause instability (at the input). The points outside the $\Gamma = 1$ circle correspond to loads with negative resistance. These are of no concern, because any amplifier might be made unstable by subjecting it to a given source or load impedance with a negative real part. Amplifier stability only requires that the circuit be stable with passive input and output reflection coefficients, that is, passive source and load impedances.

Next, consider the source reflection coefficients that cause $|\Gamma_{OUT}| = 1$. The relation of Γ_S to Γ_{OUT} is given by (see p. 142 of ref. 1):

$$\Gamma_S = \frac{S_{22} - \Delta\Gamma_{OUT}}{1 - S_{11}\,\Gamma_{OUT}} \qquad (4)$$

In a similar fashion, this can be used to map the $|\Gamma_{OUT}| = 1$ circle onto the Γ_S plane:

$$C_S = \frac{S_{11}^* - \Delta^* S_{22}}{|S_{11}|^2 - |\Delta|^2} \qquad (5)$$

and radius of

$$R_s = \left|\frac{S_{12}\,S_{21}}{|S_{11}|^2 - |\Delta|^2}\right| \qquad (6)$$

Plotting this for the transistor at 1 GHz gives the left circle outside the Smith Chart in **Fig. 3.**

The output stability circle is also called the source instability circle because it represents those Γ_S values that cause instability in the input circuit. The points within the output stability circle are unstable ones because, from the S-parameters of the transistor, $|S_{22}| < 1$ with a 50-Ω termination on the input. The output circuit may become unstable ($|\Gamma_{OUT}| > 1$) at low input source impedances.

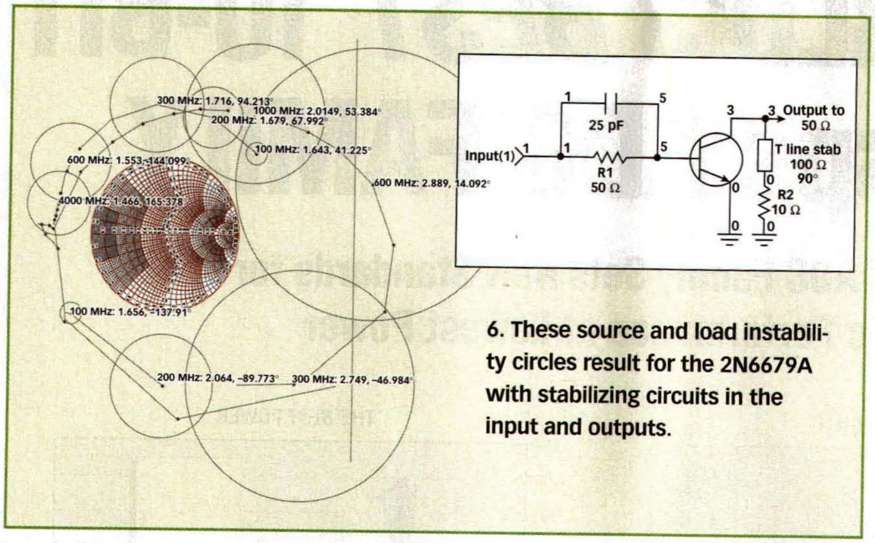
These circles indicate certain characteristics of the transistor. For example, any attempts to obtain more gain from the transistor by adding matching circuits at the input and output must avoid those impedances that would cause instability. Even if the transistor is used with only 50-Ω loads, if the source or load is removed and there is a transmission line whose length transforms an open circuit to one of the unstable impedances, the circuit may oscillate.

The examples so far have only examined the transistor's behavior at 1 GHz. For an amplifier to be unconditionally stable, however, it must be stable at all frequencies (at which the device has more than unity gain). The resulting source and load instability circles are two separate families of circles **(Fig. 4).**

Since the stability circles can be calculated directly from the S-parameters, it would seem that stability could be determined from the S-parameters themselves, without need for the stability circles. To do this, first define a stability factor, K, as (see p. 145 of ref. 1)

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}\,S_{21}|} \qquad (7)$$

where:



6. These source and load instability circles result for the 2N6679A with stabilizing circuits in the input and outputs.

$$|\Delta|^2 = |S_{11}\,S_{22} - S_{12}\,S_{21}|^2 \quad (8)$$

The amplifier is unconditionally stable provided that

$$K > 1 \quad (9a)$$

and

$$|\Delta|^2 < 1 \quad (9b)$$

Equivalently (see p. 324 of ref. 2), the amplifier is unconditionally stable if

$$K > 1 \quad (10a)$$

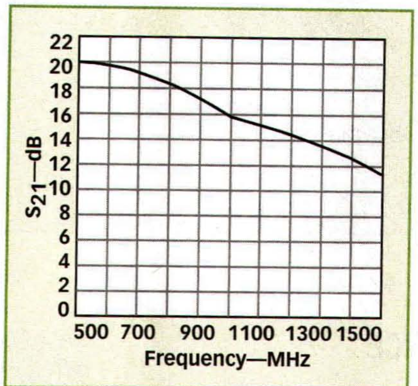
and

$$B_1 > 0 \quad (10b)$$

where:

$$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2 > 0 \quad (11)$$

Applying this test to the 2N6679A transistor and using the Genesys computer-aided-engineering (CAE) program from Eagleware (Norcross, GA) to calculate K and B_1 gives the results in **Table 1.** From these values, it is apparent that the transistor is potentially unstable at 1 GHz (and other frequencies), as had already been deduced from the input and output stability circles. The source instability circles indicate that low impedances at the input may cause instability. This suggests that a resistance placed in series with the base lead can reduce the intersection of the source instability circles with the $|\Gamma| \le 1$ circle, which will also reduce gain. However, since device instability usually peaks at low frequencies (at which the transistor has the highest gain), the resistor can be shunted with a capacitor to reduce its effect near 1 GHz. One such stabilizing circuit is shown in **Fig. 5.**



7. The gain of the stabilized 2N6679A transistor has dropped very little from the unstabilized device of Part 1.

This measure almost removed all instabilities. It moved both the source and load instability circles away from the $|\Gamma| = 1$ (passive Smith Chart) portion of the reflection coefficient plane **(Fig. 6).** Rather than add more resistance to the base lead, it is often found to be more effective to add some damping to the output. Corrections to the input stability tend to help the output stability, and vice versa.

Examining the load instability circles reveals that high output load impedances cause instability. To counter this, shunt resistance can be added at the output, placed at the end of a high-impedance 90-deg. line at 1 GHz to minimize its effect at that frequency. The shunt resistance limits how large the load impedance can be, minimizing the likelihood that a high impedance that can cause instability will be encountered at the output.

This addition to the output circuit has unconditionally stabilized the device over the 100-to-2000-MHz range, in which it previously was potentially unstable. From the K factor calculations **(Table 2)** it can be seen that the low-frequency range is well stabilized. This is important because S-parameter data below 100 MHz were not included in the S-parameter file.

The resulting gain of the 2N6679A with the stabilizing elements is shown in **Fig. 7.** In comparing this gain with that of the unstabilized transistor of Part 1, only about 0.6 dB gain is lost at 1 GHz, dropping from 16.4 dB to about 15.8 dB. The low-frequency gain has been reduced even more, which is actually a benefit. Gain outside the desired bandwidth is a liability, because it can cause instabilities. Next month, readers will learn how to match an amplifier's input and output ports for additional gain using the *unilateral gain* method. MRF

ABOUT THE AUTHOR

Joseph F. White is well known in the microwave industry as an instructor and lecturer. After having received a Ph. D. in electrophysics from Rensselaer Polytechnic Institute (Troy, NY), Dr. White spent 25 years in semiconductor and component engineering at M/A-COM (Burlington, MA) where he earned several patents for microwave design and engineering. He has also received the IEEE's Microwave Theory & Techniques (MTT) Society's annual application award for "Contributions to Phased Array Antennas."

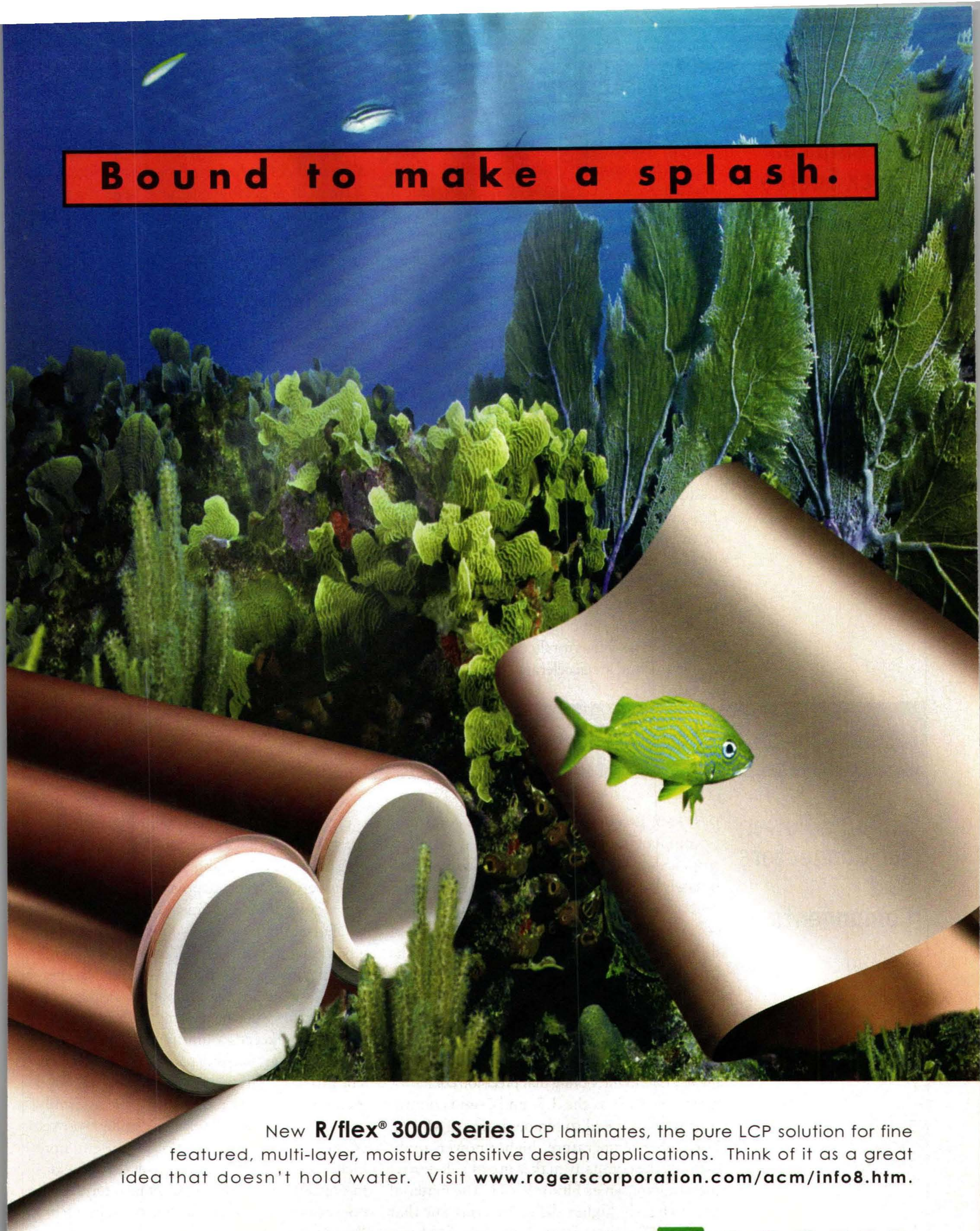
Upon leaving M/A-COM, Dr. White edited the *Microwave Journal* magazine and then founded his own publication, *Applied Microwave* magazine (later to be renamed *Applied Microwave & Wireless* magazine). In addition to writing the recently published *High Frequency Techniques* for John Wiley & Sons (Hoboken, NJ, 2004), Dr. White, who is a lifetime fellow of the IEEE, also authored *Microwave Semiconductor Engineering*, a textbook in its third printing since 1977, and now published by Noble Publications (Norcross, GA). This article series is excerpted from his new book as well as the one-week technical course that he teaches, entitled "Wireless Engineering."

EDITOR'S NOTE

This article is excerpted with permission from the one-week industrial course, *Wireless Engineering*, that the author teaches and from *High Frequency Techniques, An Introduction to RF and Microwave Engineering*, by Joseph F. White (John Wiley & Sons, Hoboken, NJ, 2004; www.wiley.com).

REFERENCES

1. Theodore Grosch, *Small Signal Microwave Amplifier Design*, Noble Publishing Corp, Norcross, GA, 1999.
2. Genesys 7 *Reference Manual*, Eagleware, Norcross, GA, 1986-2000.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On-Chip LJJ Clock Source Generates 50 GHz

SUPERCONDUCTOR TECHNOLOGY has offered tremendous promise in analog and digital high-frequency circuits for several decades. One of the pioneers in the technology, HYPRES, Inc. (Elmsford, NY) is still active in the development of high-performance circuits and devices for commercial and military applications. In particular, the company offers a technical paper on its website entitled "Two-Phase 50 GHz On-Chip Long Josephson Junction Clock Source," which details a linear long Josephson Junction (LJJ) linear oscillator capable of serving as a clock oscillator in high-speed systems requiring extremely low jitter.

The oscillator is based on resonant soliton modes in a LJJ. In this device, the soliton reverses direction upon hitting the end of the linear LJJ, changing the quantum mechanical phase at the junction boundary by $4/\pi$. Because of the low losses in LJJs, this process is repeated resulting in the resonant (back and forth) soliton mode. As the external magnetic field is increased, magnetic flux permeates into the junction. The solitons (or fluxons) are introducced at one end and are accelerated toward the other end by the junction bias current. This unidirectional flow of flux is called the flux-flow mode. With a small or negligible magnetic field, the oscillator frequency in the resonant mode is determined largely by the junction length.

Using these fundamentals, the researchers developed a LJJ master clock source capable of producing two clock streams, each at one-half the frequency of the master clock. Both linear and annular LJJ clocks were designed, with clock frequencies of 28 and 33 GHz, respectively, for the two approaches. Improvements in the basic designs have been implemented to deliver even higher clock frequencies for rapid single flux quantum (RSFQ) digital circuits.

The four-page article fairly notes that it is the cost and complexity of the cryogenic support systems needed with superconducting devices that are still limiting factors for the wide acceptance of LJJs and other superconducting devices and components. The article is free for download from the company's website.

HYPRES, Inc., 175 Clearbrook Rd., Elmsford, NY 10523; (914) 592-1190, FAX: (914) 347-2239, Internet: www.hypres.com.

The four-page article fairly notes that it is the cost and complexity of the cryogenic support systems that are still limiting factors for the wide acceptance of LJJs.

Gauging Power For Connectors And Components

DETERMINING HOW MUCH POWER a connector or component can handle can help avoid catastrophic damage to an assembly or system. Fortunately, several short technical notes are available from the Astrolab, Inc. (Warren, NJ) covering the power-handling capabilities of different coaxial connector types as well as the power handling of coaxial assemblies.

The connector note, which includes a practical chart for maing conversions between dBm and milliwatts, highlights the dielectric bead as the most heat-critical component in a high-frequency connector, noting that precision connector interfaces such as the 3.5- and 7-mm connectors are only rated to temperatures of +90°C. For higher-temperature, higher-power applications, the company makes use of a dielectric material known as Fluoroloy H. The material has a slightly higher dielectric constant that standard Teflon dielectric materials, but has a higher rate of thermal conductivity which allows heat generated in the center conductor of a connector to transfer to the outer conductor more rapidly, for higher power-handling capability than connectors with Teflon dielectrics.

The coaxial assembly note clearly differentiates between average power and peak power when rating the capabilities of a coaxial assembly. For example, average-power failure occurs when the level of power transmitted through the component results in heat that cannot be effectively dissipated by the component. Peak power failure occurs when the voltage gradient between two points exceeds a limiting value and causes a signal to arc across a path of least resistance. The article details several steps can be taken to increase the power rating of a cable assembly or component, such as the use of high-power coaxial connectors. The short but useful note includes several tables for power derating factors at diffferent altitudes and temperatures. Both notes can be downloaded free of charge from the company's website.

Astrolab, Inc., 4 Powder Horn Dr., Warren, NJ 07059-5105; (732) 560-3800, FAX: (732) 560-9570, Internet: www.astrolab.com.

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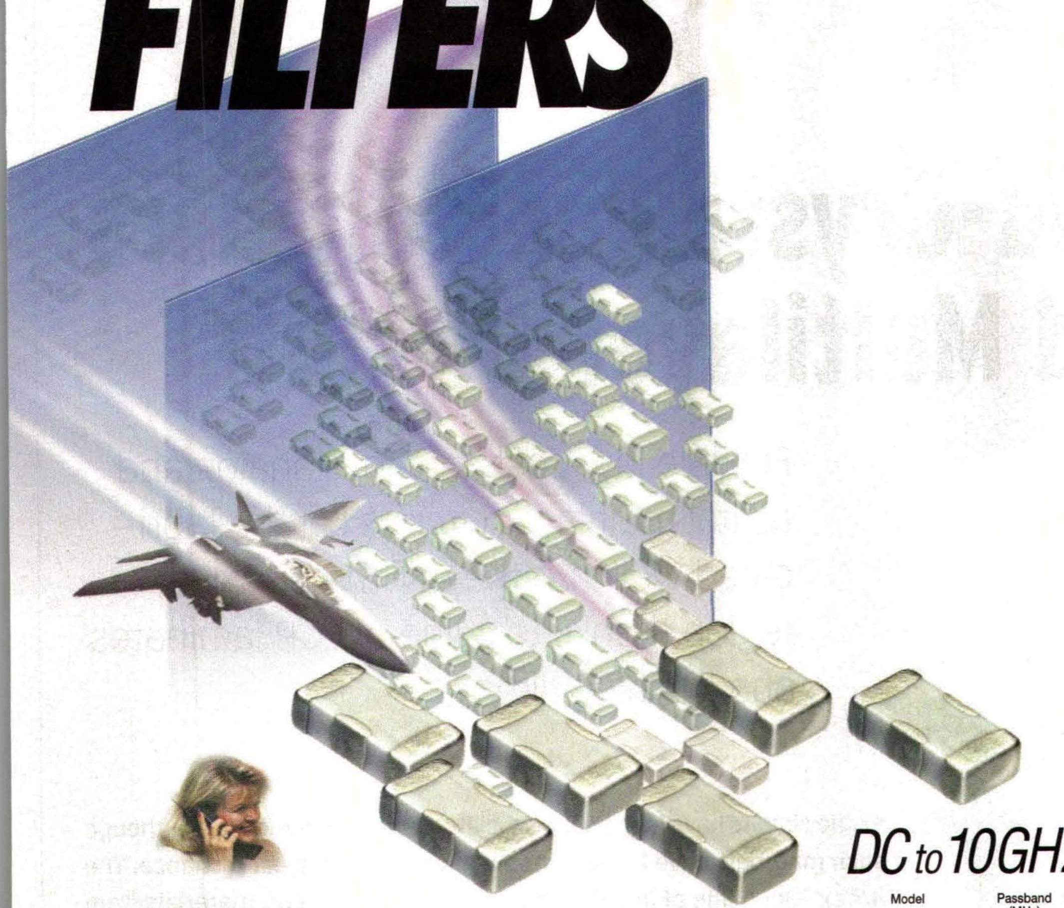

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LFCN-320	DC-320	460	560	7	2.99
LFCN-400	DC-400	560	660	7	2.99
LFCN-490	DC-490	650	780	7	2.99
LFCN-530	DC-530	700	820	7	2.99
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LFCN-630	DC-630	830	970	7	2.99
LFCN-800	DC-800	990	1400	5	1.99
LFCN-900	DC-900	1075	1275	7	1.99
LFCN-1000	DC-1000	1300	1550	7	1.99
LFCN-1200	DC-1200	1530	1800	7	1.99
LFCN-1325	DC-1325	1560	2100	5	1.99
LFCN-1450	DC-1450	1825	2025	7	2.99
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LFCN-2250	DC-2250	2575	2850	7	1.99
LFCN-2400	DC-2400	2800	3600	5	1.99
LFCN-2500	DC-2500	3075	3675	7	1.99
LFCN-3000	DC-3000	3600	4350	7	1.99
LFCN-5000	DC-5000	5580	6600	7	1.99
LFCN-6000	DC-6000	6800	8300	7	1.99
LFCN-6700	DC-6700	7600	8900	7	1.99
HFCN-650	850-2490	650	480	7	1.99
HFCN-740	900-2800	740	550	7	1.99
HFCN-880	1060-3200	880	640	7	1.99
HFCN-1200	1340-4600	1180	940	7	1.99
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HFCN-1760	2100-5500	1760	1230	7	1.99
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HFCN-1810	2250-4750	1810	1480	7	1.99
HFCN-2000	2410-6250	2000	1530	7	1.99
HFCN-2100	2500-6000	2100	1530	7	1.99
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cover story

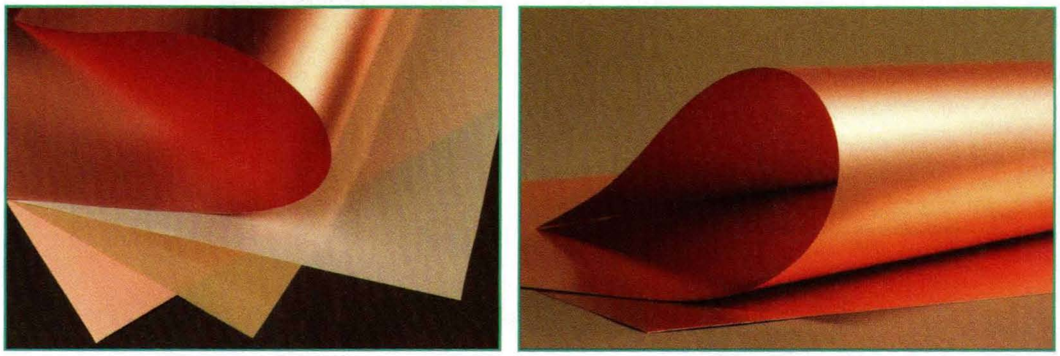
Liquid-Crystalline Polymers Bond Multilayer Circuits

Flexible low-cost, low-loss analog and digital multilayer circuits can be fabricated well into the millimeter-wave region thanks to a line of LCP laminates and bonding films.

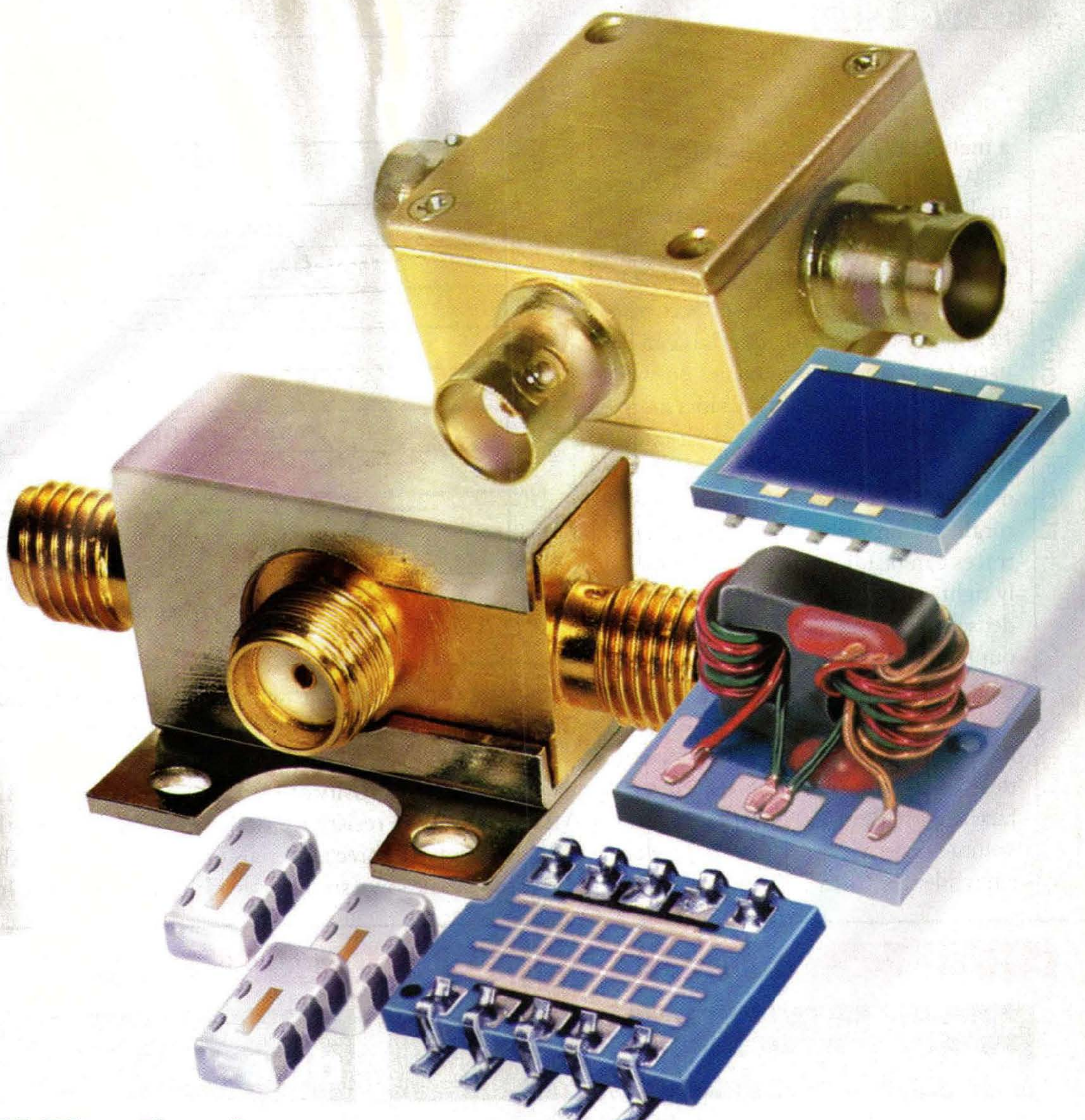
JACK BROWNE
Publisher/Editor

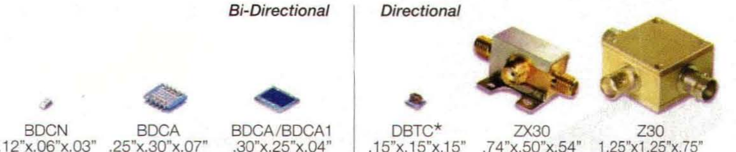
fexible circuits have long been associated with polyimide films, although such materials have been limited in high-frequency performance. The R/flex® 3000 line of liquid-crystal-polymer (LCP) circuit materials from Rogers Corp. (Chandler, AZ), on the other hand, brings all the benefits of flexible substrates to microwave design, and without the high dielectric constant and poor moisture absorption that have restricted polyimide-based substrates to lower-frequency circuits.

The Rogers LCP solution is actually a multiproduct family of materials that can be used separately or together to form single-layer or multilayer high-frequency circuits. The R/flex 3000 line includes the R/flex 3600 material with LCP dielectric and single-clad copper laminate, the R/flex 3850 material with LCP dielectric and double-clad copper laminate, and the R/flex 3908 bonding film which can be used as an adhesive layer between copper and the LCP dielectric material to form high-speed, high-frequency multilayer circuits. The single-clad and double-clad laminate materials have melting temperatures of +290 and +315°C, respectively, while the bonding film has



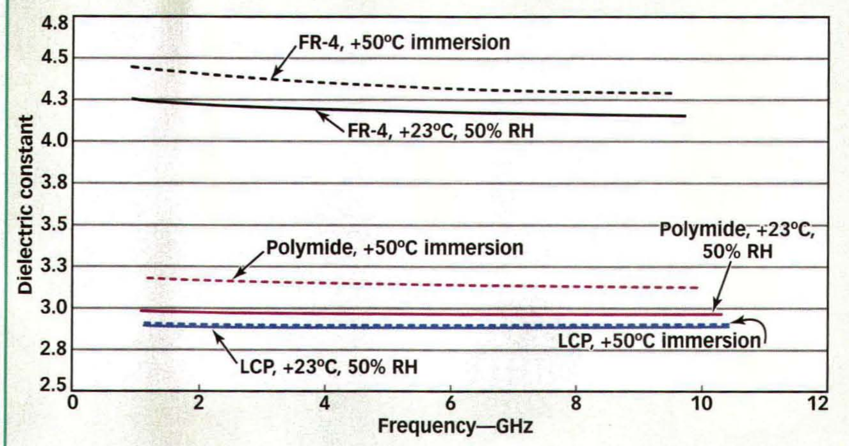
1. The R/flex 3000 liquid-crystalline-polymer flexible circuit materials are available with single-clad (top) and double-clad (bottom) copper laminate.





a melting temperature of +280°C.

An LCP film is essentially a thermally stable thermoplastic material. Since the R/flex 3000 materials share a low dielectric constant of 2.9 at 10 GHz with negligible moisture effects, the flexible-circuit-board materials can be used from audio frequencies to well past 40 GHz. These are low-loss materials, with a miniscule dissipation factor of 0.002 at 10 GHz for all three materials. Since the materials are structurally sound with temperature, circuit traces can be fabricated with extremely tight spacing, supporting extremely dense analog and digital circuitry without fear of crosstalk or signal coupling from signal traces shifting due to thermal effects. In summarizing some of the other pertinent electrical parameters, the two laminate materials feature surface resistivity of 1.0×10^{10} MΩ and volume resistivity of 1.0×10^{12} MΩ-cm while the R/flex 3908 bonding film exhibits surface resistivity of 1.0×10^{10} MΩ and volume resistivity of 1.0×10^{12} MΩ-cm. All three materials offer dielectric breakdown strength of 3500 V/mil (1378 kV/cm).



2. This plot of dielectric constant as a function of frequency reveals the uniformity of the R/flex 3000 materials at different temperatures.

Because they share the LCP dielectric layers, the laminates and bonding film show low moisture absorption

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VLF-400	DC-400	560	660	20.95
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VLF-575	DC-575	770	900	20.95
VLF-630	DC-630	830	970	20.95
VLF-800	DC-800	1060	1225	19.95
VLF-1000	DC-1000	1300	1550	19.95
VLF-1200	DC-1200	1530	1800	19.95
VLF-1700	DC-1700	2050	2375	19.95
VLF-2250	DC-2250	2575	2850	19.95
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VLF-6700	DC-6700	7600	8900	19.95
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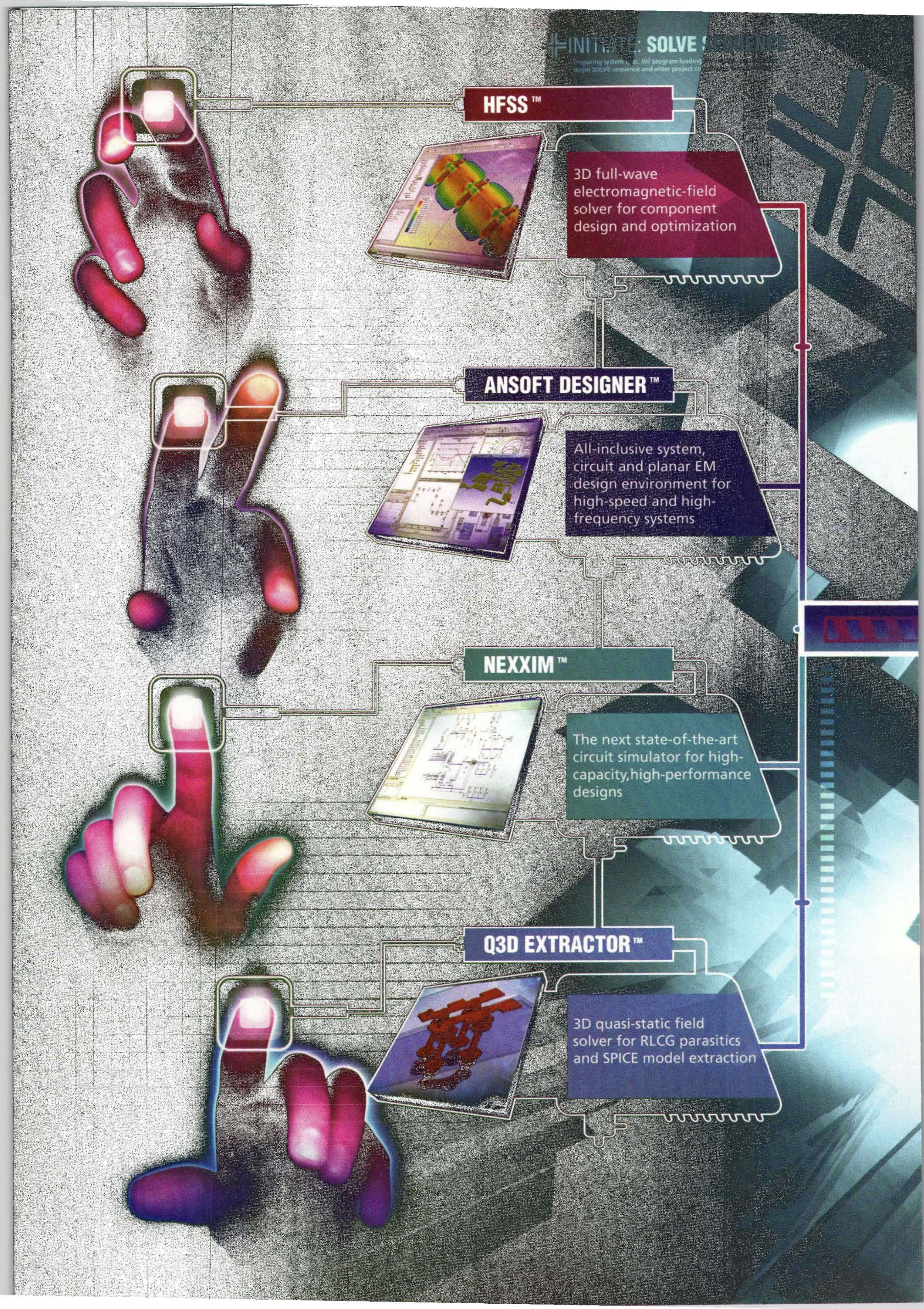

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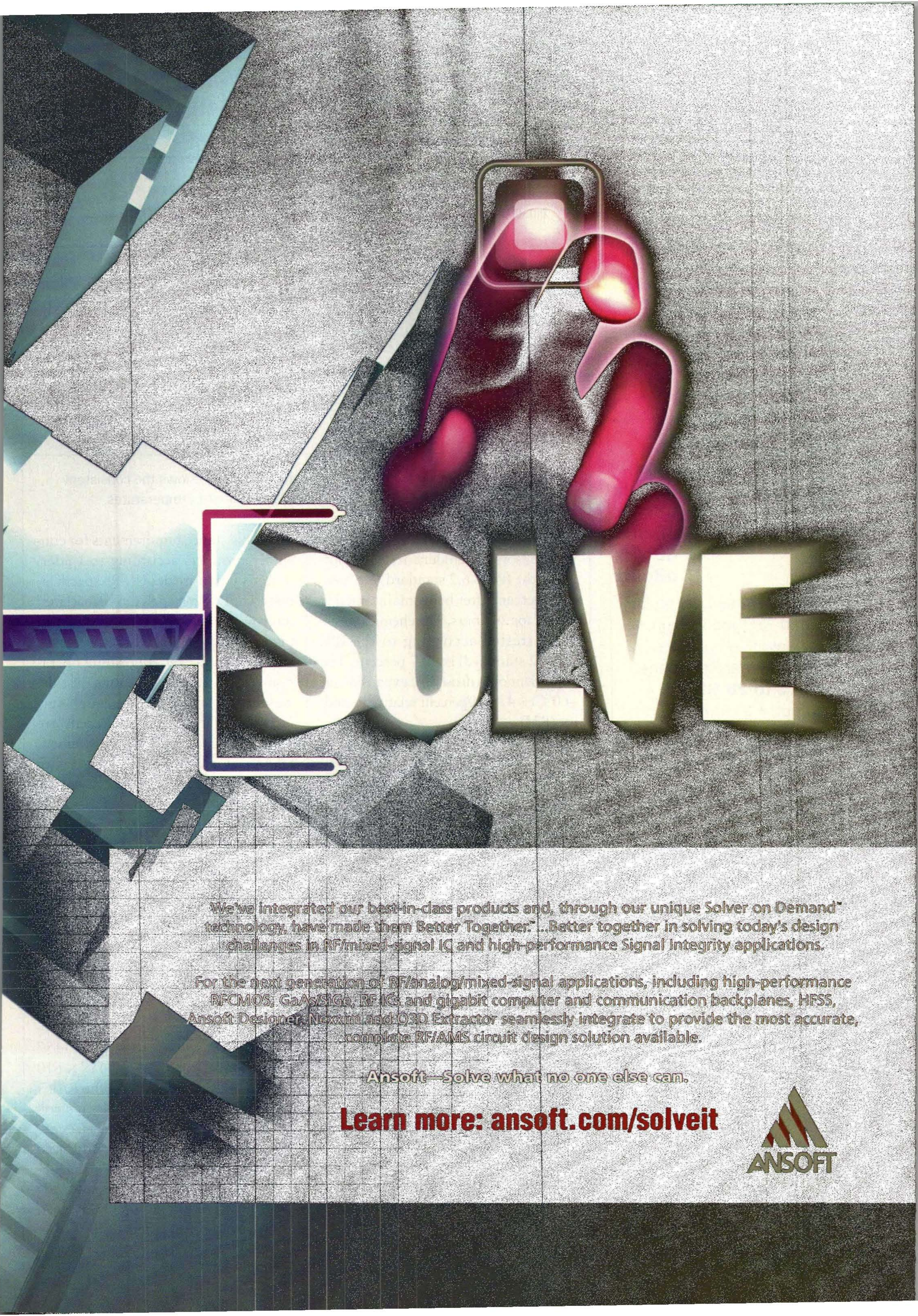
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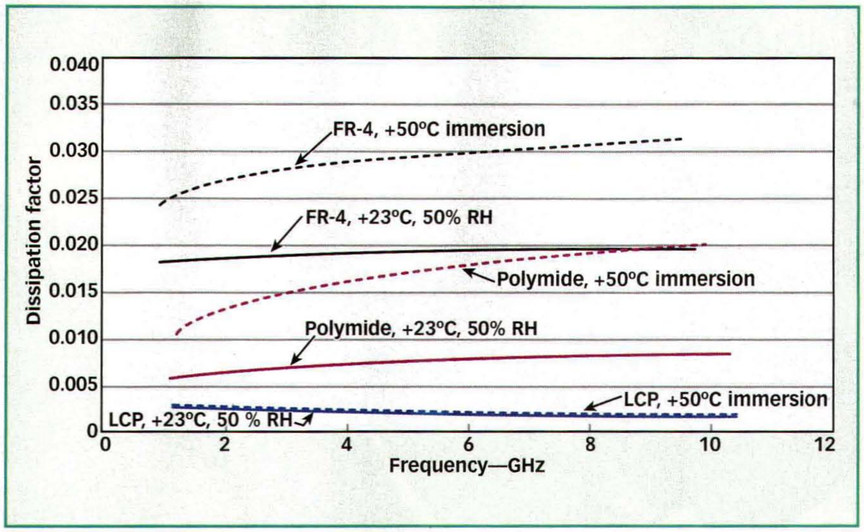

3. This plot of dissipation factor as a function of frequency shows the consistent loss characteristics of the R/flex 3000 materials at different temperatures.

and excellent chemical resistance. The water absorption amount (tested according to the IPC 2.6.2 standard) is a mere 0.04 percent after being maintained at +23°C for 24 hours. The chemical resistance (tested according to the IPC 2.3.4.2 standard) is 98.7 percent. The coefficient of hydroscopic expansion (at +60°C) is 4 PPM/percent relative humidity (RH).

The R/flex 3000 laminates and bonding materials show very little dimensional movement with temperature, with a coefficient of thermal expansion (CTE) that is 17 PPM/°C in both the X and Y directions. The amount of force to initiate a tear in the materials (minimum initiation tear strength) is 3.1 lbs (1.4 kg). The laminates are also characterized by the peel strength of their copper cladding, with values of 5.2 lbs/in. (0.95 N/mm) for the single-clad R/flex 3600 material and 5.2 lbs/in. (0.95 N/mm) for the double-clad R/flex 3850 material. The single-clad material exhibits tensile strength of 17.5 kpsi (120 MPa) and tensile modulus of 350 kpsi (2400 MPa). The double-clad material has tensile strength of 29 kpsi (200 MPa) and tensile modulus of 327 kpsi (2255 MPa). The bonding film exhibits tensile strength of 31 kpsi (216 MPa) and a tensile modulus of 355 kpsi (2450 MPa).

The R/flex 3000 materials meet flame-resistance requirements for consumer products according to Underwriter's Laboratories UL-94 specifications. The LCP materials can be machined much like polyimide or FR-4 circuit-board materials. Since they are thermoplastic materials, however, all drilling operations should avoid overheating the sidewalls (which could leave rough surfaces for plating). The materials are halogen free for minimal environmental impact, and can be processed with both CO_2 and YIG lasers. A hot oil vacuum press with good temperature control can be used for fabricating the multilayer circuits.

The R/flex 3000 materials have no special storage requirements and no limits on shelf life. The laminates are available in standard thicknesses of 25 µm (0.001 in.), 50 µm (0.002 in.), and 100 µm (0.004 in.) while the bonding film is available in standard thicknesses of 25 and 50 µm (0.001 and 0.002 in.). All three R/flex 3000 materials can be supplied in sheet sizes of 18 × 12 in. (457 × 305 mm) and 18 × 24 in. (457 × 610 mm). The R/flex 3600 and the R/flex 3908 materials are available on a roll with widths to 20 in. Custom sizes are also available. **Rogers Corp., Advanced Circuit Materials Div., 100 North Dobson Rd., Chandler, AZ 85224; (480) 961-1382, FAX: (480) 961-4533, Internet: www.rogerscorporation.com.**

Field-Strength Analyzer Scans 100 kHz To 2.9 GHz

This portable analyzer is well suited for installers and maintainers of WLANs, medical-telemetry, and other mobile and fixed wireless-communications systems.

JACK BROWNE
Publisher/Editor

Practical field-strength measurements call for an analyzer that is portable yet powerful. The model 3290 RF Field Strength Analyzer from PROTEK Test and Measurement (Allendale, NJ) is a handheld instrument that contains not only a full-featured spectrum analyzer capable of measurements from 100 kHz to 2.9 GHz, but also a sensitive frequency counter, a host of demodulators, and the choice of operating on batteries, AC, or vehicle DC power.

The analyzer **(see figure)** features a basic data-entry keypad and on-screen menu. The 3290's backlit 192 × 192-pixel liquid-crystal-display (LCD) screen provides a spectrum display or bar graph with large readout of marker frequency and smaller readouts of center frequency, reference level, span, and step size.

Based on a temperature-compensated crystal oscillator (TCXO) and phase-locked-loop (PLL) tuning, the 3290 provides ±3 PPM reference-oscillator frequency accuracy and displayed measurement accuracy of ±25 PPM. The instrument offers −117 dBm sensitivity, handles maximum input voltage of 5 V RMS, and can display levels in units of dBmV, dBμV, or dBm. It features versatile demodulation capabilities with narrowband and wideband frequency-modulation (FM), amplitude-modulation (AM), and single-sideband (SSB) demodulators. In narrowband FM mode, the 3290 operates with a 3-dB bandwidth of approximately 12.5 kHz while in wideband FM mode, the 3-dB measurement bandwidth is approximately 180 kHz. In AM/SSB mode, the 3-dB bandwidth is approximately 2.4 kHz.

Narrowband FM mode detects levels from −70 to −20 dBmV (−10 to 40 dBμV) from 300 to 1800 MHz and −60 to −20 dBmV (0 to 40 dBμV) from 1 to 300 MHz and from 1800 to 2900 MHz. Wideband FM mode allows level measurements from −60 to −10 dBmV (0 to 50 dBμV) from 300 to 1800 MHz and −50 to −10 dBmV (10 to 40 dBμV) from 10 to 300 MHz and from 1800 to 2900 MHz. Resolution and level accuracy are 0.5 dB and ±3 dB, respectively, in both modes.

The 3290 analyzer, which is ideal for testing cellular systems, wireless-local-area-network (WLAN) systems, cable-television (CATV) systems, wireless medical-telemetry systems, and satellite-television systems, supports sweeps with step sizes of 5 kHz to 9995 kHz in multiples of 5 and 6.25 kHz. The instrument boasts a scan speed of 125 channels/s. P&A: $2700. **PROTEK Test and Measurement, 40 Boroline Rd., Allendale, NJ 07401; (201) 760-9898, FAX: (201) 760-9888, e-mail: sales@protektest.com, Internet: www.protektest.com.**

The 3290 RF Field Strength Analyzer measures levels as low as −117 dBm over a frequency range of 100 kHz to 2.9 GHz in a portable, battery-powered package.

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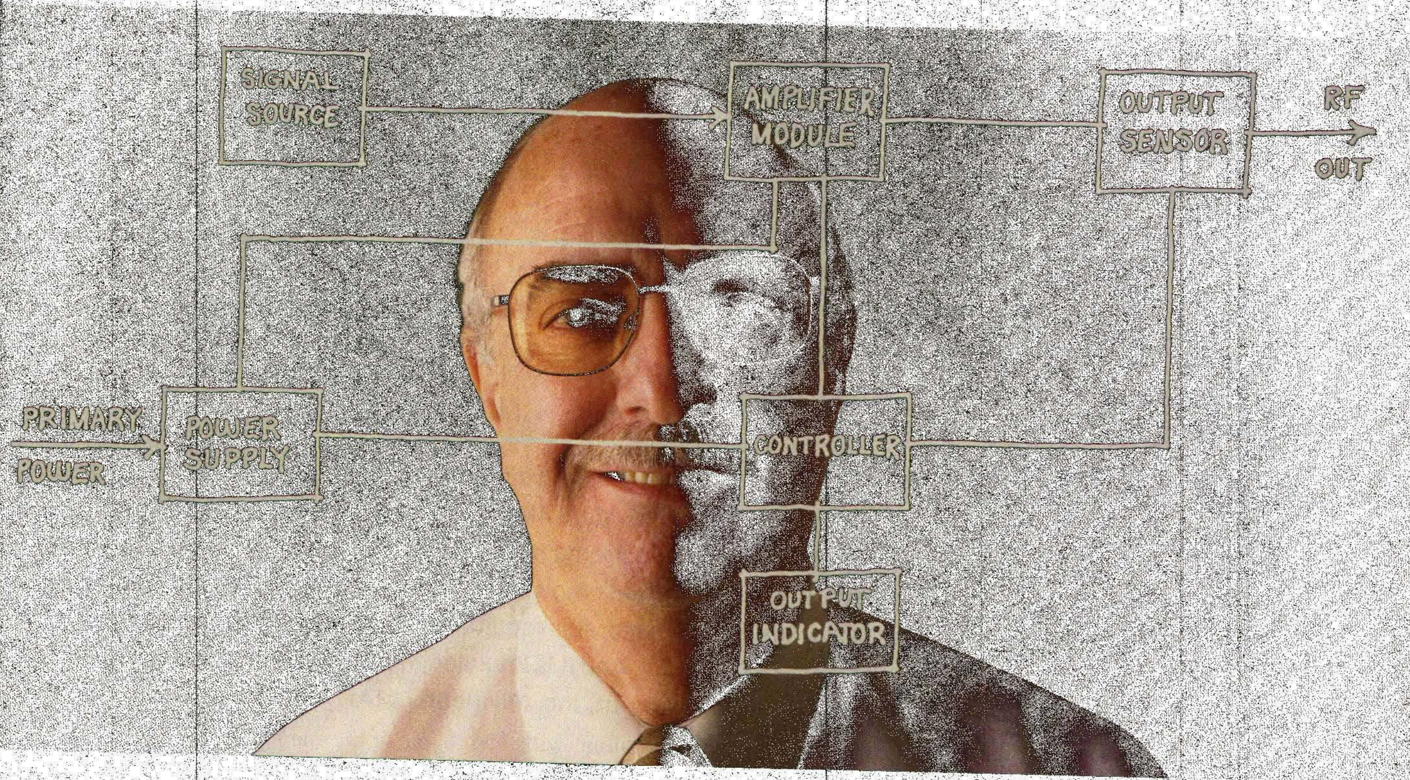

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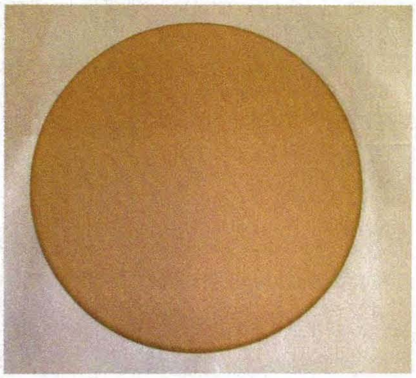
Firm Designs/Builds Microwave Antennas

JACK BROWNE
Publisher/Editor

This fledgling design and manufacturing house has already built an astonishing array of RF/microwave feeds and antennas for a wide range of mobile and fixed applications.

Antenna design is one of the remaining "mystical" areas of the high-frequency electronics industry. Although mathematical modeling software and electromagnetic (EM) simulation tools have made the task somewhat more predictable, successful antenna design still requires a great deal of knowledge and experience. And it is knowledge and experience that newcomer Micro-Ant, Inc. (Plymouth, MA) brings to the industry, along with EM modeling, manufacturing, testing services, and several lines of high-performance microstrip antennas and arrays, feeds, parabolic reflectors, and precision horns.



1. Model PCA24SR is a microstrip array antenna that delivers 21 dBic typical gain from 2200 to 2300 MHz.

2. Model WGF2XL is a light-weight scalar feed antenna that operates from 7.5 to 8.4 GHz with typical noise temperature of 70 K.

Founded by Charles McCarrick, who honed his antenna design skills under the guidance of John Seavey (Seavey Engineering) and also serves as lead engineer, Micro-Ant also boasts antenna engineer Greg Poe and mechanical engineer John Barbuto. The design team has already developed a wide range of microstrip designs (including patches and phased arrays), feeds (including symmetrical reflectors, and parabolic antennas.

For example, model PCA24SR is a microstrip array antenna **(Fig. 1)** formed from bonded layers of plastic and foam sheets. The circular antenna is 24 in. in diameter and only 0.75 in. high but yields 21 dBic typical gain from 2200 to 2300 MHz. The printed-circuit array exhibits a maximum VSWR of 1.30:1 and features typical noise temperature of 70 K.

The model PCA5LR is a microstrip patch antenna designed for the INMARSAT BGAN satellite network. Measuring only 4 × 4 × 1 in., the patch operates with right-handed circular polarization and achieves 8.5 dBic gain from 1525 to 1661 MHz. With maximum VSWR of 1.50:1, the basic design is available for other frequencies and can be supplied within a radome.

Model WGF2XL is an example of the company's feed products **(Fig. 2)**. Measuring 3.8 × 4.25 in., the lightweight scalar feed is designed for use with prime focus symmetric reflector systems. The feed, which operates from 7.5 to 8.4 GHz with typical noise temperature of 70 K, is constructed of brazed aluminum with a WR-112 waveguide flange at the RF port.

Among the firm's horn designs, model QRH13LS is a broadband quad-ridged antenna that can be used as a feed for a reflector, for instrumentation applications, or in broadband communications systems. It operates from 1 to 2 GHz with dual linear polarization (the horn has two orthogonal RF ports that can be combined via a hybrid to produce right- or left-handed circular polarization). The horn delivers minimum gain of 10 dBi and exhibits maximum VSWR of 2.0:1.

In addition to these standard designs, the company offers a host of custom antenna configurations. Services are many, and include consulting, computer modeling, noise-temperature measurements, manufacturing tolerance studies, and optimization studies. **Micro-Ant, Inc., 15 Wildwood Rd., Plymouth, MA 02360; (508) 888-0406, FAX: (508) 888-1626, e-mail: salesmarketing@micro-ant.com, Internet: www.micro-ant.com.**

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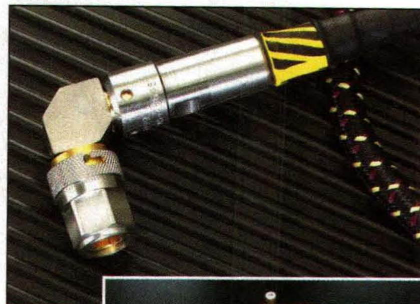

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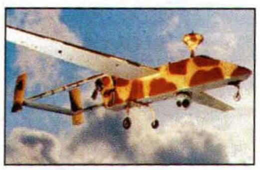

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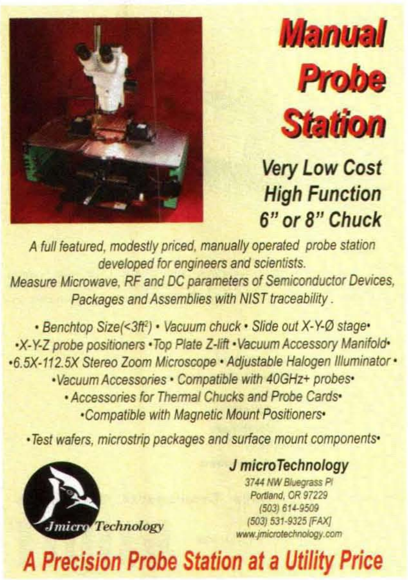

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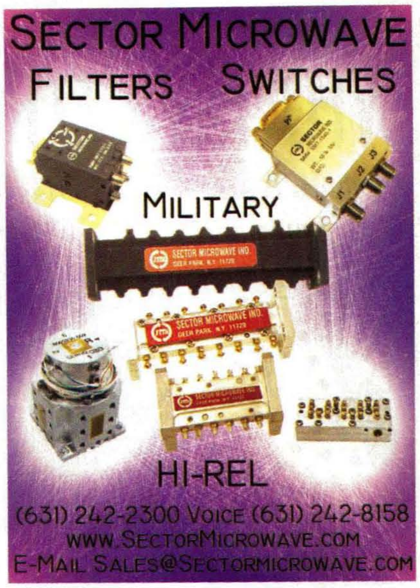

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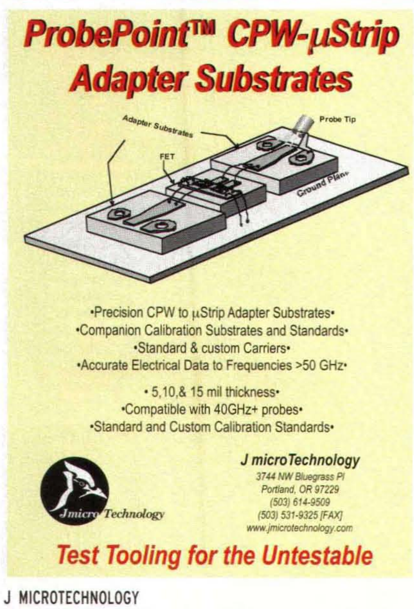

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MARKETING AND ADVERTISING STAFF

GROUP PUBLISHER
Craig Roth
(201) 845-2448
e-mail:croth@penton.com

SALES ASSISTANT
Judy Kollarik
(201) 845-2427
e-mail: jkollarik@penton.com

DIRECT CONNECTION ADS CLASSIFIED ADVERTISING
Joanne Reppas
(201) 666-6698
e-mail: jrepfrangides@msn.com

CIRCULATION CUSTOMER SERVICE (LIVE)
Phone: (847) 763-9670
Fax: (847) 763-9673
e-mail: microwaves&rf@halldata.com

NEW YORK, NEW ENGLAND, SOUTHEAST, MID ATLANTIC, DC, VA,
Paul Barkman
Global Sales Manager
Penton Media, Inc.
45 Eisenhower Dr., fifth floor
Paramus, NJ 07652
(908) 704-2460
FAX: (908) 704-2486
e-mail: pbarkman@penton.com

MIDWEST, SOUTHWEST, WESTCOAST, NORTHWEST, CANADA
Michael Barkman
Account Executive
Penton Media, Inc.
45 Eisenhower Dr., fifth floor
Paramus, NJ 07652
(908) 832-6551
FAX: (908) 832-7052
e-mail: mbarkman@penton.com

GERMANY, AUSTRIA, SWITZERLAND
Friedrich K. Anacker
Managing Director
InterMedia Partners GmbH (IMP)
In der Fleute 46
D-42389 Wuppertal
Germany
Phone: 011-49-202-271-690
FAX: 011-49-202-271-6920

FRANCE
Emmanual Archambeaud
Defense & Communication
48 Bd Jean-Jaures,
92110 Clichy
France
Phone: 33-01-47-30-7180
FAX: 33-01-47-30-0189

TAIWAN, R.O.C.
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Two-Way Communications Co., Ltd.
11F/1, No. 421
Sung Shan Road
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JAPAN
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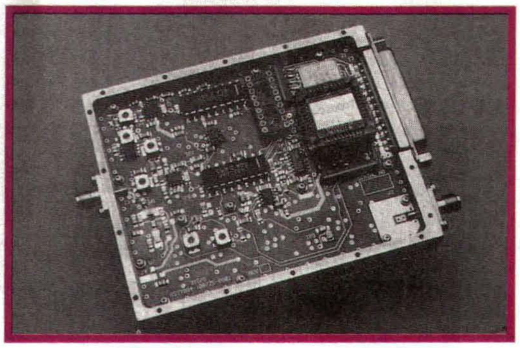
looking back



EXACTLY 15 YEARS AGO, a Product Technology piece examined a company called Mirage Systems (Sunnyvale, CA) and their quiet entry into the instantaneous-frequency-measurement (IFM) module market with a unit capable of 70-dB dynamic range from 125 to 250 MHz.

next month

Microwaves & RF September Editorial Preview

Issue Theme: Military Electronics

News

September's theme of Military Electronics is well represented by a Special Report on how Boeing overcame series limitations in the manual testing of their CH-47 Chinook helicopters. Complex avionics and instrumentation systems operating at microwave frequencies serve critical roles aboard Boeing Army Rotorcraft Systems' CH-47 and MH-47 Chinooks, MV-22 and CV-22 Osprey tiltrotor aircraft, and RAH-66 Comanche armed reconnaissance helicopters. The company's facility in Ridley Park, PA produces completed fuselages for these aircraft destined to fly for US forces including Marines, Air Force, and Army units around the globe, but was challenged in performing manual testing on these complex avionics systems.

Design Features

September carries a variety of technology articles with design approaches suitable for both commercial and military applications. An author from Germany will share details on a telemetry transmitter designed for low-data-rate applications involving weather sensors, using UHF signals for 402 to 406 MHz. Those needing low-noise sources for unlicensed Industrial-Scientific-Medical (ISM) bands will find a solution in an article on a voltage-controlled-oscillator (VCO) design capable of tuning 150 MHz around an 860-MHz center frequency. Also in September, Dr. Joseph White of JFW Technology will continue his multipart transistor amplifier design series with advice on tuning a transistor's input and output ports for increased gain using the unilateral gain design method.

Product Technology

September's Product Technology includes a focus on new lines of integrated-circuit (IC) modulators. Using a high-performance silicon-germanium (SiGe) process, these direct and quadrature modulators feature frequency coverage past 3.5 GHz with wide bandwidths and low noise. Additional product features include a dual-channel, wideband digital receiver capable of sampling DC to 3 GHz at 2 GSamples/s, a report on BNC connectors for RF and microwave applications, a line of handheld spectrum analyzers that scan spectrum to 6 GHz, and a rugged +5-VDC MEMS switch that operates to 6 GHz.